A *Guide* TO BETTER FARMING

BOOK
No. 5

FARMER'S HANDBOOK

on SOILS and CROPS

Types of Soil; Erosion Control; Maintaining Soil Fertility; Forage Crops; Seed and Seed Cleaning; Weed Control; Pests and Diseases of Field Crops; Farm Machinery; Etc., Etc.

PUBLISHED *by* THE COUNTRY GUIDE LTD., WINNIPEG

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Types of Soil

Life and the Soil

One of the most discomforting things about modern civilization is the small amount of knowledge the average person possesses. Agriculture is the oldest occupation in which man has been engaged and we are still only on the threshold of real knowledge about the intricate problems of production. Even after two or three thousand years of experience in the growing of crops, the soil, to many farmers, is only something that must be stirred up to make crops grow.

We are quick to learn about crops, varieties, diseases, markets, climate and freight rates, but the land—the soil—which is the basis of it all, still remains, for the most part, a mystery to us. Not to everyone, fortunately, for there are always a few who study and examine and explore. Some are scientists, some are travellers and a few are farmers who are interested beyond the mere production of so many bushels per acre per year. Life, however, is so closely bound up with the soil—so closely in fact that it is hard to see how there could be any life without it—that a much more appreciative and precise knowledge of soils by those who till them, would seem to be a fundamental requisite for successful farming.

It is no wonder that some men have found the study of soils an absorbing topic, especially if they have been able to study soils in different countries and on different continents; to study them in relation to their origin in point of time and the processes which have produced them; and to relate their character to climate, slope and rock formation, as well as to trace the relationship between human life and the soil of the area.

Peculiarly interesting to western Canada is the fact that "the soils developed under grasses are the most productive for the ordinary crop plants under the common system of farming." Such soils are divided into several large groups commonly spoken of as the black, brown, light brown or chestnut, and the reddish soils of desert areas. All of these soils are found in subhumid, dry and desert climates. The black, or "Chernozem" soils it is interesting to note, although they represent very large areas in the interior of continents and are found in the United States, Canada, Russia, Argentina, Australia and Roumania, have, for the most part, only been used for farming during the last 300 years. As far as the United States and Canada are concerned, we know that these black, fertile soils have only come into use during the last 75 years. Practically, their use was prohibited until railroads were built. A large part of the bread grain of the entire world is now grown on such soils, but their use was held back until the march of science had proceeded far enough and until western Europe had begun its great period of discovery and colonization.

Characteristic of Chernozem soils is a monotonous landscape, scarcity of water, limited wood for fuel and lumber, a layer of calcium carbonate two to five feet beneath the surface and within reach of the plant roots, and comparatively little erosion under natural conditions. Scanty rainfall prevents the lime from leaching out of such soils and the soil is therefore not acid. Partly because the clay of such soils does not puddle easily, the soil is favorable to the action of bacteria. Furthermore, in comparison with the time taken to form other soils, notably those developing from rocks, the soils underlying native grasses are formed quickly, grasses exercising a visible influence in soil formation even in a dozen years. The natural fertility is high and the soil structure is granular so that it is easily penetrated by roots and water.

It is significant, however, that farmers on such soils are restricted to a narrow range of crops, making specialization essential. Wheat and other cereals are the characteristic crops and more land per family is needed on such land than in humid regions. Farmers on such soils, being restricted to so few crops, are more interested in the prices for such crops. They become interested

in freight rates because they are located so far in the interior. These circumstances supplemented by the threat (and reality) of droughts, force farmers on black, grassland soils, to co-operate. The author of the book already mentioned says: "Many of our greatest movements and ideas looking toward mutual co-operation, were born in the regions of Chernozem soils."

Farther south, the soils become brown instead of black, rainfall is scantier, farms become larger, power farming becomes characteristic, livestock are fewer, farming in general becomes even more specialized. The northern and central great plains of North America are largely made up of the brown and light brown soils. In a broad way, the progress of agriculture on these brown and light brown soils has been by way of four steps; first, the Indian and the buffalo, utilizing the natural grass of the area in free abandon; second, the rancher, operating with the aid of barbed wire, the windmill and the cowboy; third, dry farming, bringing settlers and communities to practice alternate grain and fallow; and fourth, the present period of disappointing and irregular yields, wind and water erosion, leading to improved soil management and government assistance in a program of soil conservation by laying more acres down to grass.

For twenty or more years there has been a growing realization of soil problems ahead. Fundamental to the study of these problems and their ultimate solution is an accurate and scientific knowledge of the soils themselves. This requires detail surveys and examinations, not only of the surface, but the whole soil structure, subsoil, profile, topography, water supply, erosion factors, chemical nature and all characteristics and properties in relation to crops and climate. These studies have been under way on the Canadian prairies by means of soil surveys, conducted as rapidly as money has been made available by provincial governments, supplemented by federal assistance.

The Wooded Soils of the North

Some 250 million acres in Alberta, Saskatchewan, and Manitoba comprise an area often referred to as the wooded soil area of the prairie provinces. This vast territory includes nearly two-thirds of the total area of Alberta, about one-half of Saskatchewan, and a quarter of Manitoba. A very small proportion is settled as yet, but this is the land which will absorb much of Canada's expanding population in the future.

A prairie farmer, or even a dweller in the park country, can have little conception of the sort of soil found in the heavily wooded areas, unless he has seen it. For untold years, poplar, spruce, pine, willow, birch, alder, have grown on this land. Because wooded soils tend to remain damper than prairie soils in summer, there is a greater tendency toward leaching, which is the term given to the loss of plant food as water carries it to lower levels. Another factor contributing to this leaching or soil degradation is the absence of (free) lime, which, when present, retards the leaching process. Probably never as rich in this lime as prairie soils, most of the small supply has been lost through weathering. The absence of grass sod, too, is to a great extent responsible for leaching.

The characteristic light grey color of so much of this wooded soil is due to soil degradation. In the poorest of this, the grey color extends to a depth of three feet or more. Where a better soil type is found, this grey layer may be only from three to six inches deep. Wherever grey soil is found it is rather ashy in texture and bakes easily after a rain.

Soil analysis has shown that the top two inches of the average wooded soil is almost identical with the top twelve inches of black soil. This is a fairly accurate gauge of their relative productivity. Under favorable weather conditions many wooded soils will produce two or three good crops of cereals, but soon will not support a normal growth.

In a comparison of the upper three feet of the bush and the black soils it has been found that the latter contains almost four times as much nitrogen as the former, one and one-half

times as much phosphorus and calcium, and one and one-third times as much magnesium. This does not necessarily mean, however, that the grey soils are not relatively fertile. Most of them compare favorably with productive soils in various parts of the world.

Peat lands, too, form a considerable portion of these wooded areas. It is estimated that Alberta, alone, contains some 25 million acres of muskeg and swamp. It is unlikely that any great proportion of the large areas ever will be reclaimed. Where relatively small acreages are of this type, it often is advisable to drain them and bring them under cultivation.—J. T. Ewing.

Erosion

Wind Erosion

George Spence, director of P.F.R.A. activities in western Canada, had a few pertinent remarks to make on the question of soil drifting and the farmer's responsibility.

"Peculiarly enough," said Mr. Spence, "many farmers regard soil drifting as an act of God, rather than the direct result of their own faulty cropping practices. It is noticeable, too, that soil drifting is a greater menace in districts where large scale operators are the rule rather than the exception.

"Certainly, a great deal of educational work remains to be done. The fact must be driven home, however unpalatable it may be, that soil drifting is the result of bad cultural practices, which the farmer himself is wholly and solely responsible for. The land is a heritage, which we are only holding in trust for future generations; and if we are to build permanent homes on these prairies for ourselves and our children, the native soil fertility must be maintained and the structure of the soil preserved by means of the best known cultural practices which science and practice have so far evolved. This is one of the jobs that the P.F.R.A. has been organized and equipped to undertake.

Water Erosion

So far in the history of prairie agriculture much more damage has been done by soil drifting or wind erosion than by water erosion. The latter, however, is increasing in importance and, in some parts of the prairies, serious damage has already been done.

Water erosion is an insidious form of damage to soil because few farmers pay much attention to a small watercourse across the field, or to the movement of some soil down the slope following a rain. Erosion by water is of two kinds, that is, the soil moves in two different ways. The first is what is known as gully erosion, which cuts channels through the fields as the result, usually, of a heavy rain; and these channels interfere with cultural operations. Also as a result of these gullies a certain amount of land is rendered unfit for use. The second kind of water erosion is called sheet erosion. This may be merely the moving of small amounts of top soil downward in the direction of the runoff. No unsightly gullies are formed and the injury is much less apparent. After a time, however, a gradual removal of the top soil to other parts of the field leaves light-colored spots on the top of ridges, or on the sides of slopes. Sometimes the top soil is completely removed by sheet erosion and the lighter colored sub-soil is exposed.

Erosion Control

The Roots of Grasses

The total weight of root fibre present in an acre of native prairie soil, one foot deep, is approximately six tons, dried weight. This is an astonishing figure to anyone previously unacquainted with the fact. Few people would have imagined that six tons of dried roots could be removed from the top foot of surface.

soil, over an area of only one acre. Such, however, is the statement of Messrs. T. M. Stevenson and W. J. White of the Experimental farms service, who commenced a project at the Dominion forage crops laboratory to determine the relative root fibre production of the three principal cultivated grasses in the drier areas of the prairies. These grasses are Crested wheat grass, brome grass and slender wheat grass; and the reason for the work undertaken, lies in the fact that "the basic cause of wind erosion (soil drifting) is the small size of the soil particles." It was known that the use of grasses increases the size of soil particles and thus tends to prevent drifting.

The result of the investigation was to reveal several interesting facts about the root production of grasses and to verify previous opinion that Crested wheat grass is superior to brome grass in increasing the size of soil particles. Slender wheat grass is of little or no value, according to the investigators. This is partly because slender wheat grass has the smallest and weakest roots and Crested wheat grass the strongest.

About 88 per cent of the root fibre production of the three grasses was found to be in the top foot of soil, with about seven per cent in the second foot and the remainder in the next three feet of soil. Taking the top foot of soil only and dividing it into three-inch depths, about half of the roots present were in the first three inches; about a quarter in the second three inches; about 15 per cent in the next three inches and about one-tenth in the soil from 9 to 12 inches deep. Every year that Crested wheat grass stands in the soil it adds to its root system and it was found that five-year-old stands have been able to build up as much as three tons of root fibre, dry weight, this being about half the quantity present in native prairie. Figures presented also would seem to indicate that Fairway crested wheat grass is no more rapid in establishing its root system, but that after about the second year, it develops a larger quantity of root fibre in the top foot of soil than does the common variety. An area of Fairway down eight years showed 8,055 pounds of fibre yield per acre-foot, whereas the common yielded only 7,140 pounds.

Crested Wheat Grass

The Dominion Range Experiment Station at Manyberries, Alta., recently reported an interesting experience with Crested wheat grass in a very dry year, which it would be well to keep in mind.

"In 1936," so we are told, "one of the driest years on record, an abandoned farm field near this station was sown to Crested wheat in the early spring. Throughout the remainder of 1936 and during 1937, which was another dry year, not a sign of a stand of the grass could be observed. Almost miraculously, in the early summer of 1938, a perfect stand appeared, and it has done well ever since. The stand developed so rapidly in 1938 that it was suggested that the small seedlings were probably established the previous year and escaped detection."

Crested wheat grass seedlings are very small, fine and inconspicuous when they first come up; and if the crop is sown in trash, stubble or weed covers, they may be even harder to see. When quite small, pasturing will cause damage to the seedlings from the livestock trampling over it, so that it is best to wait until a stand has been assured.

Crested Wheat Grass Sod is Toughest

Crested wheat grass sod is much tougher than Brome sod and both are tougher than Western rye grass sod, according to plowing tests made at Scott, Sask. As G. D. Matthews points out, this has a direct effect in the use of these grasses in controlling soil drifting. He says:

"An examination of the sods showed that the roots of Western rye grass decay readily as the plant grows older, which accounts for the low draft in this grass. In the Brome the running root stalks were comparatively large and fibrous. It had a much better root system than Western rye in amount and strength of root fibre, but was not equal to Crested wheat grass in density and strength of roots. In Crested wheat

grass the roots were much more numerous. finer and stronger. The mass of strong roots in the sod of this grass, which retain their toughness for a longer time after plowing than either of the other grasses, makes it the most valuable grass in controlling soil drifting."

For those who are interested in this matter the following figures are illuminating: A 4-bottom mold-board plow drawn by a tractor was used. Three tests were made, plowing four, five and six inches deep. Plowing at four inches the draft for Crested wheat, Brome and Western rye was 2,228, 1,975 and 1,475 pounds respectively. Plowing five inches deep the corresponding figures were 3,000, 2,375 and 1,750 pounds. Plowing six inches deep the draft rose to 3,190, 3,195 and 2,313 pounds. The Crested wheat grass dropped to approximately the same draft as Brome grass when plowed at the six-inch depth. This may have been due to the considerably thinner stand of the Crested wheat grass. The average draft at the three depths was Crested wheat, 2,806; Brome, 2,515 pounds; and Western rye grass, 1,846 pounds.

Light Seedings of Crested Wheat

Some interesting results have been obtained at Manyberries Experiment Station from a project designed to determine how rapidly very thin stands of Crested wheat grass will thicken up to the point that will assure maximum forage production.

In 1936 Crested wheat grass seed was broadcast by hand on abandoned farm land at rates of one to three pounds per acre. By 1938 very thin stands of grass were appearing, and from 5 to 15 plants were charted per square metre quadrat. This worked out to a density of ground cover that varied from one-half per cent to two per cent. In the fall of 1940 these plots were recharted and it was found that the number of plants per square metre had increased more than threefold. From 20 to 140 plants were charted on the same area. In addition many small seedlings were also noted. At the present time the density of this grass cover ranges from four to eight per cent.

It can be assumed that with favorable conditions this stand of grass will continue to thicken up at the same rate for the next year or two. By this time it may have a density of ground cover that is equal to or better than the native prairie in the same area. Such a cover will assure maximum production of either hay or pasture, depending upon the amount of rainfall received.

These results would indicate the practicability of rehabilitating abandoned farm lands by seeding Crested wheat grass at rates as low as one pound per acre. In four to six years such seedings promise to produce worth-while stands if the grass is grazed only in the fall, winter, and very early spring, so that it will have an opportunity to set seed each year.

Such light seedings mean that a limited amount of seed will cover a relatively large area of land, and eventually produce an economical stand of grass. The length of time required to obtain such a stand will, however, be materially reduced as the rate of seeding is increased to the optimum of five to six pounds per acre.

Cover Crops for Soil Drifting

In some areas where the rainfall is adequate to take care of it, a cover crop will not only provide pasture for stock later in the season, but will also provide protection against drifting. Oats are most frequently used, but it is often claimed that for the drier areas barley will germinate more quickly and cover the ground sooner than oats. Oats may also be objectionable on the score of wild oats, unless the seed is entirely free of this weed. It might be advisable to use the same kind of grain that is to be sown on the land the following spring in order to prevent volunteer plants, from seed that does not germinate in the fall.

The time of seeding the cover crop will depend somewhat on the availability of moisture. Generally speaking,

seeding should not be later than August 1, but if fall pasture is desired, earlier seeding is better where moisture permits. Danger from cutworms and grasshoppers is also a factor, since late cultivation favors cutworm activity. On the other hand, later seeding, after the majority of grasshoppers have ceased feeding, will be advantageous in some circumstances. Aside from these considerations, the real guide as to date of seeding the cover crop is to get the necessary cover, and pasture if required, without drawing too heavily on soil moisture by too early seeding.

Heavy cover crop growth in naturally dry areas may seriously reduce the yield of the following crop, but as a rule, where cover crops have been used, the decrease in yield has not been material. Certain weeds may be difficult to control where a cover crop is used; and, where the cover is used for soil protection alone, the expense of seed and seeding is to be considered, as is also the possibility of drought and grasshoppers destroying the cover crop and leaving the soil bare.

The rate of seeding is substantially less than for a grain crop and the customary rate is half a bushel of spring wheat or three-quarters of a bushel of oats or barley. These rates are considered sufficient to provide the necessary cover, though later seeding would require a slightly heavier rate. Again, the rate is adjustable on the basis of pasture requirements, soil type, as well as time of seeding.

Burning Straw and Drifting Soil

If we are growing wheat for the grain alone, I favor leaving as much straw as possible on the field as stubble. If we cut with the combine we'll leave it all there, but the part that goes through the machine should be spread again by the use of the straw spreader, with which all large combines are sent out. This standing stubble will catch a lot of snow, and the threshed straw will help to hold this moisture the following spring. If the two-year rotation is followed, this stubble and trash, worked in with a one-way, is a real asset to resist drifting.

Although the use of the binder is decreasing, a lot of heavy straw crop is still handled that way. Why not leave as much of this straw as possible right on the field, as long stubble? And do we make real use of our straw-piles? I don't think so.

If we let a few head of cattle run at a pile all winter, they do make a mess of it. Quite true, they may feed themselves for a few months, then we try to burn the remains and usually can't farm that area for the next five years. Both the straw and the ground it stood on is nearly all wasted.

If a little care is exercised by the separator man, many of these straw-piles can be made into straw stacks. If in the late fall, we haul a few loads away and leave straight sides at least four feet high, they won't drift up badly with snow. Then they should be fenced with a real stock-proof fence, and the result will be a worth-while stack of feed.

As the trend is to more livestock, these strawstacks can be made real use of, for we will have a good supply of clean, dry straw for rough feed or bedding. It is a little more labor to take the straw to the stock than the stock to the straw, but the former has many advantages. Quite often we can spread the straw where we want the cattle to spread manure for us. If we have some knolls that are inclined to drift, this is a good way to hold them down. Or, if spread in a pasture field thinly enough, it will improve the stand of the grass in coming years. But it has to be spread very thinly for this.

Even though there may not be much feeding value in straw for livestock, there is a lot of comfort value for them if it is used right. They like the chaff best and if it is spread out this way, they can all get a chance at it. With much more oats and barley available for feed, more cattle will be fattened on the farms and it is the contented animal that puts on the weight.

We have new machines to help us in our work too. These two-wheel trailer manure spreaders would be a slick rig to use behind a light tractor. These baby combines (four to six-foot cuts) can be used in many places and for

many crops that the big ones can't handle. They leave the straw right where it grew. A "one-way" can handle a lot of stubble and straw and a good blade cultivator can go under almost any amount.

Burning straw and stubble must have some advantages or it wouldn't be done. I'll admit that it does get rid of weed seeds and trash, but better farming practices would reduce the growth of these weeds. And all weeds take moisture from our crops, moisture that we usually can't afford to lose.

Down in the southwest corner of Saskatchewan, where we live, we have some large P.F.R.A. community pastures where we used to have small farms. This land, that by the old burn-and-rub method, was growing very poor crops of wheat, has produced some wonderful stands of Crested wheat grass. Once established, these stands crowd out all weed growth. All available moisture goes to the grass plant and all the plant can be eaten by stock. There is no waste or burning there.

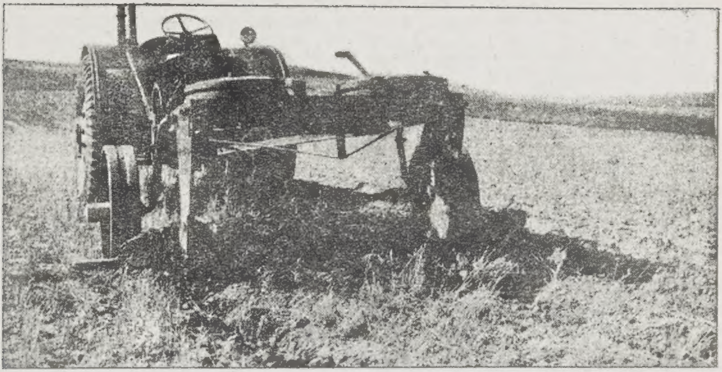
I believe we should all do our part to reduce the burning of straw-piles, stubble and weeds, for burning stubble is a good way to start soil drifting. Given a box of matches, a tractor disc and a windy day, some of these farms are a mile square and two miles high!—T. L. Shepherd.

Holding the Trash Cover

No longer is it considered to be the acme of good practice to leave the soil close-cultivated and bare of any covering for the wind to blow the surface soil off to the neighboring field or roadside. Exponents of early and frequent cultivation of fallow and those good farmers who hate to see weeds growing unchallenged in any field of theirs, or those farmers in parts of the grain-growing areas where soil drifting has never been a serious problem, would shrink with shame from the appearance of many fields in the drier areas that now represent the height of sound scientific practice.

The trash cover is responsible. Trash means anything that can be made to lie on the surface, keep the top soil from moving and hold the snow in winter. Stubble and weeds, of course, are the common materials; and the use of weeds introduces a problem, since it is certainly not desirable to permit them to grow and reproduce themselves. This problem is further complicated by the fact that unless the trash is anchored to the soil in some way, it cannot be as effective and is itself likely to be moved and blown about by the wind.

The Noble blade has been used satisfactorily at the Dominion experiment station, Swift Current, in an effort to solve this problem. This implement is nothing more than a heavy blade



mounted on two sturdy standards behind the two riding wheels. The blade is several inches wide, curved, and we were informed that it will scour well in any soil. It is operated at a depth of four or five inches below the surface, power usually being furnished by a tractor.

The curved blade causes the four or five-inch layer of soil above it to heave and roll over the curved surface and settle back again with the stubble and trash still anchored firmly to the soil. Weeds growing at the time are broken off below the ground, but the broken upper parts remain anchored with the stubble. The accompanying illustrations show the blade at work on the station at Swift Current, one of them (above) showing the blade out of the soil, to indicate the depth at which it was working and having one end cleared of soil. Both illustrations showing the machine, illustrate also the appearance of the worked land after the blade has passed through it, the appearance being pretty much as it was before, except for the trail of the standards to which the blade is fastened.

One difficulty at Swift Current, as explained to an editor of The Country Guide by G. N. Denike, Assistant in Farm Machinery, is that with each successive use of the blade it tends to work a little deeper, since a hard shearing surface under the blade is necessary for complete cutting. For further work, once the Noble blade has established a firm shearing surface, V-shaped weeder attachments have been designed. These weeder attachments have a rounded edge for tearing out weeds and have a chisel point to hold them in the ground. Since they follow the blade weeder, which has established a firm shearing surface, they have a tendency to pack the soil under the lower weeder edge, and thus have a definite tendency to work up closer to the surface with repeated weeder attachment operations. The chisel point travels in the firm soil below the shearing level, thus keeping the weeder attachment blade from running out at hard spots and helps maintain a uniform depth of work.

This V-shaped weeder attachment is sometimes used in light or loose soils without previous work, but it is only possible to use it successfully where conditions are ideal, otherwise it is necessary to first establish a definite depth of work with the blade. When repeated operations of the V-shaped attachment result in a depth of working which is too shallow, it will be necessary to use the blade to again establish the desirable depth.

To use the weeder attachment, the blade is removed and the V-shaped attachment fastened to the two standards of the Noble blade machine. In the illustration, Mr. Denike's right hand points to the chisel point on the attachment. (See page 7.)

The first finger of his left hand curves around the shearing edge of the flaring blade. This edge it is important to note, is not sharp, but is well rounded. The rounded edge pushes a thin layer of soil ahead of it when in operation, producing a shearing action by reason of the fact that the pushing of a thin layer ahead of the blade, coupled with the heaving of the remaining soil over the blade itself, makes the layers of soil move at different speeds and thus shears off weed growth.

Wind Proofing the Soil

In areas where there is danger of spring winds sufficiently severe to cause drifting of the soil, the Dominion experimental station at Lethbridge recommends wind-proofing the soil in the fall by means of the plow, duckfoot cultivator, or lister. Listing is the usual method and considered to be the most effective. Often this is done with a duckfoot cultivator equipped with lister shovels, so as to provide furrows about 3½ to 5 feet apart.

Where an ordinary duckfoot is used, it is advised that every other duckfoot should be removed and the duckfeet tilted so as to make as big a furrow as possible. In answer to the objection that some farmers have to the lister, namely that it makes the field hard to cultivate in the spring, Lethbridge suggests that this difficulty can be easily overcome by using the duckfoot cultivator on the listed fields in the spring and running the duckfoot in the same direction as the listing. Where the ordinary duckfoot is used, it is recommended that a sack be wrapped around the shank immediately above each duckfoot, since this helps to do a better job of ridging.

If listing is not considered advisable and the duckfoot is not deemed to be efficient enough, a good job, but a more expensive one can be done by fall plowing. Fall plowing for wind protection should be two or three inches deeper than the land was worked during the summer, in order to completely cover the loose soil.

Modified Strip Farming Methods

The main advantage of strip farming is that it prevents the drifting soil from spreading over large areas. Provided the stubble strips are of sufficient width to trap any soil moving off adjoining fallow land, additional width does not appear to have any effect in controlling soil drifting. Strip farming in itself will not prevent soil drifting. This can only be accomplished by careful cultural practices.

The chief disadvantages of strip farming are the difficulty of controlling sawflies, due to the increased number of edges and the narrowness of the fields; the rigidity of the system, which makes it difficult to meet variations in climatic conditions and the changing demands in production; and the limitations of its use on different types of soil.

The possibility that sawflies were liable to increase and cause considerable damage to wheat crops, especially under a strip farming set-up, has long been recognized. Consequently, experiments were started at the Dominion experimental substations in southwestern Saskatchewan in the spring of 1939 with the primary object of finding some method of farming which would maintain the advantages of strip farming and at the same time overcome some of its disadvantages. This system involves a re-arrangement of the regular strip farming. Instead of having the strips all the same width, wide strips are alternated with narrow ones. During the fallow year, strips of fallow from 16 to 32 rods, depending upon the susceptibility of the soil to drifting, are alternated with strips seeded to oats and ranging in width from three to four rods. The following year the fallow strips are seeded to wheat and the oat strips are worked for fallow. The width of the fallow strips can easily be changed, depending on the amount of stubble available for creating a trash cover, by leaving out or adding additional oat strips.

Under this system, sawflies can be eliminated from a large block of land by a combination of summerfallow and a limited acreage of oats. The following year, when the land is seeded to wheat,

an effort is made to prevent the sawflies from reinfesting the field. This can be at least partially accomplished by seeding a trap of wheat 28 feet wide around the entire block, and leaving a bare strip of equal width between the trap and the main crop.

This experiment has now been conducted for five years. During that period it has been found just as effective in controlling soil drifting as the regular strip farming; and the damage from sawflies has been substantially reduced

In the original experiments the oat strips were 28 feet wide. It was found that such strips were too narrow because it was impossible to work such narrow strips without turning on the adjoining strips. The optimum width is from three to four rods

Up to the present time there has not been any instance where the oat strips failed to produce a stand, although the yields of grain have not been as good as on larger fields. If the oat crop should fail for any reason, the emergency soil drift control measures would have to be resorted to. Plowing furrows probably is the most effective. In this connection it must be pointed out that emergency methods are much more effective if started before the problem gets out of hand. Furrows should be plowed if the land looks as if it might start drifting, or at the latest, when the first signs of drifting appear.

Much progress has already been made in the control of soil drifting. Much information has been obtained on sawfly control. In spite of this there still is considerable soil drifting and the sawflies continue to cause severe damage. There are, however, two new developments which may completely change the situation. The widespread adoption of such implements as the blade weeders, should they prove entirely satisfactory as tillage machines, may solve most of our soil drifting problems. The development of a sawfly-resistant wheat, on which considerable progress has already been made, would overcome the sawfly problem. On the other hand, new developments may lead to new problems.

In the past, we have endeavoured to find some standardized, rigid system of farming which could be followed under all conditions, only to find that our farming practices had to be changed with each new development, or with each new problem. In an area where soil conditions are so variable and climatic conditions fluctuate so widely, it is very doubtful if a standardized system of farming is desirable. It would appear much more logical to attempt to develop a system of farming sufficiently flexible that changes can be made quickly and efficiently and full advantage taken of any favorable development or any emergency met that may arise.—P. L. Janzen.

Water Erosion Control

Generally speaking, the control of water erosion is brought about by decreasing the amount of water that runs off the soil. This decrease can be secured either by encouraging moisture to soak into the soil, or by preventing the movement of water. If the soil is left rough, water will soak into it more readily than if the surface is smooth, or dusty. Grass or other vegetation on the surface prevents, or retards, the movement of water; and this, in turn, leads to increased absorption of water by the soil owing to the fact that the vegetation causes the water to move more slowly and gives the soil more time to soak it up. Stubble or trash on the surface of summerfallow acts in much the same way.

In the United States it is estimated that 50,000,000 acres of land formerly cultivated, have been practically ruined for further cropping; and that an additional 50,000,000 acres are almost in as bad a condition. This would be serious enough, but soil conservation authorities calculate that an additional 200,000,000 acres is also suffering from erosion, some of it seriously damaged already. All of this and more has occurred during a period of 100 years, so it is not surprising that during the 40 or 50 years settlement has been definitely under way in prairie Canada, substantial damage has been done already to our most important and most valuable natural resource.

Various practices can be followed in order to avoid dangerous run-off from

prairie soil. The maintenance of organic matter in the soil will help, because such soil absorbs more moisture than those in which the organic matter has been exhausted. Bare summerfallow, on sloping land especially, should be avoided. Where land does slope and must be cultivated, cultivation should be across the slope; and if even this is not practicable, some ridging implements used at intervals across the slope will check the flow of water. Seeding across the slope, rather than up and down, is preferable; and contour strip cropping is very widely practised in the United States where damage has been most severe. Natural runways across fields should be seeded to grass in order to prevent the development of gullies; and steep slopes should also be seeded to hay or pasture crops with very steep slopes kept permanently under grass.

It may be possible to divert the flow of water before it reaches a gully that is already formed, or finds a place in the field where a gully is likely to start. Manure or straw spread in the bottom of the gully will give temporary protection.

The danger is that farmers generally will under-estimate the importance of water erosion. The time to realize its seriousness is before it takes place and the best method of avoiding loss is to prevent it.

Maintaining Soil Fertility

Run-down Land Can Be Built Up

Land once eroded can never be made "as good as ever," but soil that has suffered from neglect can be improved to the point where it is better than average.

The Wisconsin experiment station calls attention to an example of this in a farm that was so run down and badly washed that its average return per acre was much below the average for the district. Oats ran 5 to 10 bushels per acre and hay crops were weedy and low yielding. Ten cows on the farm produced only 1,300 pounds of butterfat when the farm was made a soil experiment station in 1933.

Since 1939 the land has supported 21 cows producing 4,000 pounds of butterfat per year; corn has yielded 23 bushels per acre more than the county average and barley five bushels more; and hay, mostly alfalfa, has averaged three-quarters of a ton more than the average for the county. The average per acre return in dollars has been about $9.00 above the county average.

These results have been achieved by testing the soil, applying lime and fertilizer as required, farming on the contour as much as possible to reduce erosion, converting gullies to grass waterways, using a long rotation with plenty of hay on the steeper slopes; and by better feeding of livestock with the larger crops obtained from the farm.

The station authorities point out that it takes centuries to build a virgin soil and that the time to save soil that is becoming less productive is now, when it is still worth conserving.

Practical Crop Rotations

M. J. McPhail, superintendent of the Dominion Experimental Station, Melfort, advised that crop rotations suitable to the farm or the area in which farming is carried on, should be adopted. Commenting on a six-year rotation of summerfallow, wheat, grass (two years), wheat and oats, Mr. McPhail expressed the opinion that such a rotation did not fit the conditions incidental to a transition from more or less exclusive grain growing, to mixed farming. It required smaller fields than farmers are inclined to use.

"Then, too," said Mr. McPhail, "grass seed costs money and breaking up of sod requires extra power. For these reasons the less often it is necessary to seed down grass, or break up sod, the greater the saving effected, provided the grass is rotated around the entire farm often enough to keep up the organic content of each field.

"Furthermore, no one knows just how long it is advisable to leave a field down to grass and it will vary with the seasons. At Melfort, most of the land is so badly polluted with stinkweed, that the first hay crop after seeding is unfit to be used as feed. This circumstance results in a rather small quantity of hay being harvested from a field, in proportion to the work expended, if it is to be left down for only two seasons.

"A rotation that appeals to me is one in which the farm is divided into four fields, one of which would be seeded down for an indefinite period, while on the other three, a grain rotation of summerfallow and wheat, followed by coarse grain, would be carried. When the owner decided that the area in grass should be broken, one of the other fields would be seeded down and the grain rotation shifted to include the one that had been in grass originally.

"Such a system has the much-needed merit of being flexible. As time went on the period that each field was left in grass might become settled to a definite number of seasons, but during the time when farmers are changing from the raising of cash crops to a more diversified system, they will adopt, or at least try out, a flexible rotation much more readily than they will one that is not. Such a plan, of course, will lend itself to a lesser or greater number of fields.

"From the standpoint of producing feed, sweet clover will fit into a short rotation very well, but it should be remembered that this plant will not add much fibre to the soil."

Rotations Have a Cumulative Effect

At all of the Dominion experimental farms across western Canada and on the various sub-stations and illustration farms, work has been going on for years in the testing of cropping systems to suit the various parts of the country and the different soils and climatic conditions encountered. One of the most interesting experiments in crop rotation has been under way for the last 30 years at the Dominion experimental farm, Lethbridge, on irrigated land, where a ten-year rotation has been practised. This consists of wheat, row-crop (potatoes for 11 years and sugar beets 19 years), oats, barley and alfalfa for the last six years of the rotation. Since 1933, part of the area has been fertilized and part has not, the fertilized part getting 100 pounds of 11-48 fertilizer on the second, fifth and eighth years of the rotation and all of the area getting an application of 12 tons of barnyard manure in the ninth year. This rotation, incidentally, has given the highest yields per acre of any cropping system used at any Dominion experimental station across Canada.

Grain Averages

The interesting point is that, for 30 years, wheat has yielded an average of 52.3 bushels per acre, oats, 95 bushels per acre and barley, 61.2 bushels per acre. This is for 30 years. Comparing these yields with the average for the nine-year period from 1933 to 1941, when fertilizers were applied to a part of the area, it is possible to see whether yields per acre have been heavier than when the rotation was first begun 30 years ago. In other words, it is possible to see whether rotations really do build up the soil and gradually improve yields year by year.

Take wheat. The average for 30 years was 52.3 bushels, but the average for last nine-year period, even on the unfertilized part, was 60.4 bushels per acre, while it was 62.2 bushels on the fertilized portion. The use of the rotation alone seems to have been responsible for an increase in average yields of 8.1 bushels per acre, of this crop. Take oats. The long-period average from 1912 to 1941 inclusive was 95 bushels per acre. The average for the nine-year period, on the unfertilized portion, was 101.7 bushels, and for the fertilized part, 106.2 bushels—a 6.7 bushels average increase due apparently to the soil improving value of the rotation alone. In the case of barley, the results are similar. A long time average of 61.2 bushels is to be compared with a nine-year average of 69.4 bushels, where no fertilizer was used; and 69.3 where fertilizer was used (fertilizer applied in the second year evidently had no effect on the crop of

the fourth year). The rotation improved the soil for barley to the extent of 8.2 bushels per acre.

Sugar beets have only been grown for 19 years, but the 19-year average yield was 14.64 tons per acre, as compared with a nine-year average, on unfertilized soil, of 15.81 tons and on the fertilized soil of 18.92 tons.

For comparative purposes, some rotations as practised at Lacombe, in the same province, are interesting. For 28 years the common three-year rotation of summerfallow, wheat, wheat has been followed. Over the 28-year period wheat on fallow has yielded an average of 25.8 bushels per acre and wheat on stubble has averaged 16.1 bushels. For the five-year period 1937-41, however, wheat on fallow averaged only 18.3 bushels and wheat on stubble 13.6 bushels, a reduction of 7.5 bushels in average yield for the wheat on fallow and 2.5 for the stubble. The result of a long-continued rotation that does not build up the soil, but is directed solely to the conservation of moisture and the control of weeds by cultivation, which, incidentally, pulverizes the soil more and more from year to year and tends to break down the soil structure. Such soil must be fertilized to maintain the long-time average yield, as was proven by the fact that when 50 pounds of ammonium phosphate were added to the fallow wheat soil, the average yields for the last five-year period were increased for both the fallow and the stubble wheat crops. A six-year rotation, however, involving corn (fertilized by 15 tons of barnyard manure), wheat, barley and three years of hay, brought about average yields of wheat on fallow over 31 years of 31.2 bushels (34.2 bushels for the last five years). In this six-year rotation, every crop in the rotation has shown heavier yields in the last five years than for the entire period of from 18 to 31 years, thus confirming the results on this point obtained at Lethbridge and elsewhere.

Crops that Co-operate

Many have learned of the value of co-operation among people. But it may be new to some ardent believers in human co-operation to think that our important field crops also like to help one another if given a chance. This is due to the different kinds of root systems which different crops possess and to the various effects produced in the soil when they are grown.

Grain crops, for example, have fibrous roots which fan out through the soil and subsoil in search of moisture and other plant food. Perennial grasses also have fibrous root systems but since they have more than one year to grow, they naturally tend to fill the soil with a greater amount of root fibre than the cereals which have only one short season in which to grow. The amounts vary, of course, with the kind of grass, but fortunately, our two leaders, brome and Crested wheat grass, are very productive of fibre in the soil.

Legume crops have branching tap roots which penetrate into the soil, very much like the roots of a tree. Peas and beans, which make all of their growth in one season do not have as extensive root systems as sweet clover which lives for two seasons and alfalfa which lives for several years. These last two crops have deep, extensive roots that penetrate into the subsoil and when they decay after the field is plowed up, leave little channels into the subsoil which encourage rains to pentrate, thus improving the subsoil moisture supply and preventing losses of both water and fine soil from surface run-off. In the very dry season of 1924, we had 24 bushels of wheat per acre on alfalfa summerfallow as compared to 16 bushels on summerfallow that had grown grain previously.

In addition to the beneficial effects of the root systems, the legume crops help to maintain or replenish the supply of soluble nitrates in the soil. They do this by means of bacteria which live in little nodules on their roots. These bacteria are able to absorb and digest the nitrogen and the oxygen that they obtain from air between the soil particles and convert these substances into

a plant food called nitrate. This nitrate is readily absorbed by the plant roots and a part of it is passed on to the stems and leaves above ground. In an experiment conducted in South Dakota, some years ago, it was found that the nitrogen supply was maintained but did not increase when the alfalfa hay was removed and no manure returned over a period of eight years.

By feeding legume hay or by using such fields for pasture so that the manure is returned to the soil, it is possible to enrich the soil in this valuable plant food. It is also possible to do so by plowing a legume crop under as green manure. In my experience, sweet clover has been the most economical crop to plow down. It does not cost much to sow it with oats or wheat and it will be ready to plow down at the proper time for summerfallowing in early June of the next year. In order to avoid too much loss of moisture through growing the crop, it is best to plow it under early, when it is only eight to twelve inches high if the hay is not needed for feed.

Alfalfa fields could be used in the same way but the seed costs more, so that unless one is in a seed-growing district, alfalfa is generally not economical as a green manure crop. It is better to leave alfalfa fields at least six years to produce crops before plowing them for fallow. The hay is fed and the manure is returned to fields where it is needed.

Peas and beans are legumes and are known to be useful in the formation of nitrates but they are both rather risky crops to grow and it has never seemed desirable to grow them on a very large scale in these provinces. A small acreage of beans and peas is a small risk and, if successful, is generally profitable. One farmer told me that he made enough profit from his peas to offset his losses on wheat. It is true, however, that these crops are risky; beans because they cannot endure frost and peas because they lack drought resistance. For those reasons, neither peas nor beans have been grown to a sufficient extent in recent years to become a drug on the market.

From the above discussion, it will be seen that crops are willing to cooperate to the mutual benefit of themselves and their owners. These benefits accrue in various ways. Labor is spread over a longer season than when only one or two crops are grown. Rainfall is utilized to better advantage because, in some seasons, the rains come at favorable times for perennials and biennials, while in other seasons rains come at just the right time for annuals. In some of the years that have been hard on the grain crops, we have had enough spring and winter moisture to make good hay crops, while in 1940 and some other years, the rains came too late for the grasses but just in time for the wheat, oats and barley.

Certain types of insects and plant diseases are very particular about their hosts. That is, they will starve out, rather than live on a crop which they do not fancy. This is not true of all field insects and plant diseases but it is true of a sufficient number of them to make this matter of pest control of real importance in planning for better farming through crop rotation.

All of this leads up to the requirements of a good rotation. If we are to gain all of the benefits possible we should have some acreage of each of the different types of crops; some wheat or barley, some oats, some alfalfa, some perennial grass or grass mixed with alfalfa and in types of farming where a short-lived legume will fit in, we can use sweet clover or beans and peas.

Besides those crops, we have to provide a means of killing weeds and conserving moisture That means to do some summerfallowing and to grow some inter-tilled crops such as corn, potatoes grown in cultivated rows.

We have been experimenting in the field husbandry department of the University of Saskatchewan for many years with the object of learning as much as it is possible to learn with the means at our disposal, about different methods of crop rotation. The soil used is a moderately heavy clay loam that is relatively new, having only been cropped for about a dozen years at the time the experiments were started. On such land, it was not to be expected that very distinct differences would be noticed in the early years of the experiment for the land is by no means worn out.

However, we have carried on the work year after year and every season adds to our knowledge regarding the effects of crop co-operation and to our assurance of the desirability of diversified farming.

The experiments were laid out in 1921 and 1923 and were well established by 1925. They included all the important crops grown continuously, to compare with crops grown in various rotations.

Moisture conservation has been introduced by means of summerfallowing, corn growing and producing oats in cultivated rows. Alfalfa is utilized in a field which remains for six years before it is plowed up and fallowed. Sweet clover is worked into a three-year and also into a five-year plan. Grasses are utilized in comparison with alfalfa in a six-field plan.

Thus, it will be seen that these experiments are designed to compare all grain growing, with and without moisture conservation, with rotations containing legumes and grasses.

Leave Grasses Down Longer

One of the interesting things that we have learned is that after many years, the returns per acre in money value have been at least as good and in most cases better where legumes were introduced into the cropping system than where the grain has been grown on summerfallow or on summerfallow, followed by two crops of grain. Since the soil condition is already showing definite signs of improvement in the rotations containing legumes, it looks as though their use would be desirable even if there were no gain in acre income. Grasses remaining only three years after sowing in a six-year rotation have done their part by adding fibre to the soil, but our experience points to the desirability of leaving grasses down for a longer period, probably five or six years, or even longer if they are doing well.

Sweet clover is a biennial and is used to advantage in a five-field rotation consisting of fallow, wheat, corn, oats and sweet clover. We call this our Rotation A and we like it very well. The sweet clover has made two cuttings of hay each year except in 1937 when only one small crop developed. It is followed by a full season of summerfallow to kill out stray plants and to conserve moisture.

Alfalfa is a perennial and can usually be depended upon for at least six years. In our Rotation I, we lay out four fields, one of which stays in alfalfa for six years from time of sowing. The other three fields rotate by the ordinary plan; fallow, wheat, oats, twice around. When the time comes to plow the old alfalfa field up, a new field is sown with the oats. The old field is fallowed the following year. Thus, in the course of time, alfalfa is grown on all four fields.

It is impossible, with the means at our disposal, to try out every possible method of rotating crops that will prove desirable under different local conditions of soil and climate, but by sticking to first principles in planning the experiments, we have been able to accumulate a fund of information that is adaptable to various local situations.

For example, in some districts, it may be more difficult to secure a stand of grass than it has been here, where we have lost only three stands in 20 years. In such districts, a stand of grass once secured, should doubtless be left more than three years from time of seeding.

The Annual Plan

In order to derive benefits from crop co-operation, it is necessary to take the first step. That first step is to draw a plan of the farm for 1941. This can

be done in the winter, when there is sufficient time to give real thought to it. Keeping in mind that we ought to have some grass and some legumes and a certain amount of summerfallow for moisture conservation or weed control, consider carefully, just how much of each crop you believe can be grown to good advantage on your farm.

Remember that oats and wheat are good co-operators, that barley and rye are too close relatives of wheat to permit easy separation when they follow one another in the rotation and become mixed due to volunteer growth and that they are also susceptible to some of the same pests. Then avoid having wheat, barley and rye in close succession whenever possible. It may be better to think of barley and rye as wheat substitutes, rather than as crops to rotate with wheat.

Each year thereafter, draw up this annual plan and try to improve on the original. In the course of three or four years, you should have your co-operative cropping plan pretty well established. It is easy to remember which way you want the crops to change if you just number the fields on the plan, so that the crops move on in reverse order of field numbers, as the seasons go by. A perennial crop like grass or alfalfa can be left without a number, as it will stay several years in one place.

Progress toward good, soil-conserving crop rotation is slow, but steady. If we study the agricultural history of older regions, we will see that there have been two choices open to the agriculturists. The first choice is rotation, fertilization and soil conservation; the second is single cropping, declining yields and eventual soil ruin. It seems to me that there can be no doubt that the intelligent people of the prairie provinces will see fit to make the right choice, using care and caution to make changes that will be sound and sure.

Years of research and experimentation have given us a group of crops that are adapted to the conditions of soil and climate existing here. By thoughtful management it is possible to utilize hardy alfalfa, brome grass, Crested wheat grass or sweet clover, as well as good varieties of the different grain crops and thus let them co-operate for the good of the individual farms and prairie provinces as a whole.

—Professor Manley Champlin.

Cultural Practice for Wooded Soils of the North

Some 250 million acres in Alberta, Saskatchewan and Manitoba comprise and are often referred to as the wooded soil area of the prairie provinces. This vast territory includes nearly two-thirds of the total area of Alberta, about one-half of Saskatchewan, and a quarter of Manitoba.

Peat lands, too, form a considerable portion of these wooded areas. It is estimated that Alberta, alone, contains some 25 million acres of muskeg and swamp. It is unlikely that any great proportion of the large areas ever will be reclaimed. Where relatively small acreages are of this type, it often is advisable to drain them and bring them under cultivation.

Where the peat is not more than two feet deep, satisfactory crops usually may be produced, because roots will be sent down into the mineral soil below. Deep peats sometimes may be successfully burned off, but only after careful consideration of the local conditions. Fields may be left in a very irregular condition, or if the peat is too shallow it may leave too little organic matter for a good seed bed. Although peat will burn very well after a long dry spell, great care should be taken in setting fires at such times, as such fires often are very hard to extinguish. They have been known to burn for three years, or more.

In handling such land it is best to pasture it for two or three years. By that time, according to the Alberta University's Soil Department, it may be more easily broken, because of the tramping of the livestock. Barnyard manure, or commercial fertilizer containing potash as well as nitrogen and phosphorus, sometimes increase the yield of peat and land crops. Very acid peats should be treated with lime in some form. Green feed is the best crop to raise first on such land. Later, oats or barley may be ripened. Rye, too, may

be recommended, but not wheat. It is probable that most reclaimed peat land will be eventually seeded down to grass and clover, as this is the easiest way of handling such soil.

Most of the Alberta tests of the grey wooded soils were made on the University experimental plots near Breton. To broaden their scope, co-operative tests were made with 43 farmers in various districts. Experiments at Breton showed that most of these soils would produce good crops indefinitely if certain precautions were taken. Tests made in farmers' fields substantiated these findings.

It long has been an accepted fact that legumes are extremely valuable in building up the productivity of any soil. Barnyard manure and commercial fertilizers also are of great assistance in improvement of soil fertility. A combination of these has been found most effective in increasing production on the grey bush soils.

Fertilizers recommended for black soils are less satisfactory for wooded soils. Those containing a fair amount of sulphur, in addition to nitrogen and phosphorus, have proved best; and include ammonium sulphate, 16-20 ammonium phosphate, and potassium sulphate.

Barnyard manure was less effective than either ammonium sulphate, 16-20 ammonium phosphate, or potassium sulphate. Very good results were obtained by the use of both manure and triple super-phosphate. Potassium phosphate with 16-20 ammonium phosphate produced the highest increases of all.

Their relative cost had a considerable effect on the economic value of the fertilizers. Manure was not assigned a specific value, but each ton was worth sixty cents on the basis of the value of the yield increases. It was not applied every year, but the amount averaged eight tons per acre for each year. Ammonium sulphate was one of the least expensive fertilizers, costing about $40 per ton. It also was one of the most effective in inducing increased yields, and showed the greatest annual increase, amounting to $6.54 per acre. While 16-20 ammonium phosphate combined with potassium phosphate gave the largest increases, its higher cost made it less valuable than ammonium sulphate. Alone ammonium phosphate has produced yield increases similar to those of ammonium sulphate, but its extra cost ($48 per ton) has rendered its use uneconomic excepting when used on the first crop after clover or alfalfa. Potassium sulphate also has given very satisfactory increases in yields, but its relatively high cost of $60 per ton puts it pretty well out of the running.

Any of these fertilizers should be drilled with the crop at the rate of 50 to 60 pounds per acre. When applied to legumes, a lower rate may be used.

When cereals were grown after clover or alfalfa, the really high yields were obtained. The combined effect of fertilizers and clovers doubled and trebled the yields of wheat, oats, and barley. Alfalfa was only slightly less effective. Yields rapidly declined from year to year when cereals followed each other after clover, even though fertilizers were applied in each case.

Grain grown on unfertilized grey soil often is of inferior quality. Wheat may have a protein content as low as seven per cent. It is surprising to see, on the same land, its protein content jump to 13, 14 and even 16 per cent after clover. The different fertilizers had varying effects, as may be noted from the illustration. However, some quality was lacking in the protein so that bread made from wheat with the highest protein content still was inferior in color and texture.

As to market grades, where wheat was grown continuously it graded higher than that grown after clover. This is further proof that the protein content of wheat cannot be estimated by its appearance. Barley grown on this soil under any conditions was judged to be of excellent quality for malting. Oats of good quality also were produced.

Increases in yields of clover and alfalfa, as well as straw of cereals has been no less spectacular than that of grain crops when fertilizers were used. In general, the fertilizers which induced the greatest increases in yield of grain had a similar effect on yields of hay. When two crops of alfalfa were cut during the season this legume outyielded all others. A mixture of Altaswede (red) and Arctic sweet clovers

gave high yields, too. Arctic sweet clover and timothy seeded together produced yields much below the others. Where ammonium sulphate, 16-20 ammonium phosphate, manure-triple superphosphate, or 16-20 ammonium phosphate-potassium sulphate fertilizers were used, yields of all hay crops were between three and four times as great as those obtained from unfertilized plots.

Legumes commonly recommended for improvement of grey wooded soils are alfalfa (Grimm, Ladak, Ferax) sweet clover (Arctic), red clover (Altaswede), alsike clover, white or Dutch clover, and peas.

Alfalfa probably is the best legume for such soils, with sweet clover a close second. Altaswede red clover is a selection made from a variety introduced from northern Europe. It is fairly hardy and has given high yields of hay and of seed on some wooded soils. Alsike is slightly hardier than Altaswede on moist soils, but is not drought-resistant. White or Dutch clover has a place in pasture mixtures, but its low yield renders it unprofitable as a hay crop. Peas are an excellent forage crop. Mixed with oats they are a highly nutritious feed. They like a moderately cool, moist climate, but are fairly drought-resistant. Production of seed of any of these legumes may be very profitable, as has been proved by many farmers.

Where ample moisture is present a light nurse crop, preferably of barley may be seeded to provide some return from the land while the legume is becoming established. It is advisable to seed alfalfa without a nurse crop. The small seeds of legumes should not be buried deeper than one-half inch in the soil. A firm seed bed should be prepared to delay as much as possible the evaporation of moisture near the seed. Packing after seeding is recommended unless a press drill is used and the rate of seeding recommended is about twelve pounds per acre. Where a mixture of Altaswede and Arctic sweet clover were sown in the Breton plots, each was seeded at the rate of six pounds. Legumes may be seeded anytime between May 15 and July 1.

Since legumes' chief value lies in their ability to assimilate nitrogen from the atmosphere through nodules on their roots, care must be taken to insure development of these nodules. Inoculation of seed provides this insurance. The bacteria responsible for the nodules will be present in soil after a crop of legumes is grown, provided the seed has been inoculated. However, not all legumes can be hosts to the same inoculation group. Alsike, Dutch, and red clovers belong to another inoculation group, while the different kinds of peas and vetches belong to a third group. Still another group is represented by garden beans and scarlet runner beans.

When inoculating seed of any of these groups, two methods are available. Soil which is known to contain bacteria of the proper group may be sprinkled over the land where the seed is to be sown, at the rate of about 300 pounds to the acre, and harrowed in immediately. This method may be modified by causing the inoculated soil to adhere to the seed by forming a paste of the soil, mixed with water, or by moistening the seed with a solution of water containing five per cent of glue.

The second method, and the one most commonly used is to obtain pure cultures of each kind of bacteria required. This may be obtained from your university at a cost of thirty-five cents per bottle. Each bottle contains sufficient culture to inoculate a bushel of seed.

Soil Fertility

The original fertility of prairie soil was built up from grasses, but with the spread of settlement, these grasses have been plowed up and destroyed. During subsequent years, under a system of grain production alternated with summerfallow, our farming practice has not included any large quantity of hay or pasture by which to maintain the original soil fertility. In any case, soil must be down to grass for a number of years before there is much improvement in actual soil fertility.

M. J. Tinline, Dominion experimental farm, Brandon, points out that barnyard manure, which is the fertilizer in most common use on the farm, is the most useful for soils low in organic matter; and on hill tops suffering from water and wind erosion it not only

reduces soil losses, but adds organic matter. The plowing under of ten tons of manure per acre adds 100 pounds of nitrogen and 50 pounds of phosphoric acid, whereas a 30-bushel crop of wheat takes up only 30 pounds of nitrogen and 12 pounds phosphoric acid. Thus barnyard manure has a more lasting effect than the light applications of commercial fertilizers found economical.

Dr. J. L. Doughty, Dominion experimental station, Swift Current, points out that use of the combine, which is now general, returns all the straw to the field and consequently adds fresh organic material to the soil in this way. This fresh organic material, when added to the soil, stimulates bacterial activity. Increased activity of soil bacteria may lower the nitrogen content; and since nitrates are essential for plant growth, the subsequent crop in its early stages may show some lack of nitrates, especially during a cold, wet spring on heavy land. This condition, however, only lasts a short time and after three or four weeks, according to Dr. Doughty, the nitrates are formed more rapidly than they can be used by the bacteria which bring about the decomposition of the straw.

This circumstance or condition may have a bearing on crops seeded in land into which a heavy stubble has been worked just prior to seeding. However, as soon as the soil becomes warm and moisture conditions improve, the nitrate shortage will correct itself, but where it is necessary to get the crop started as early as possible and force it to grow rapidly in order to get ahead of weeds, some application of commercial fertilizer containing nitrogen may be highly beneficial at this stage.

Mr. Thline points out that commercial fertilizer can be applied with less labor cost than barnyard manure, and in addition to stimulating growth early in the season, fertilized crops frequently mature earlier and generally increase crop yields. It has been the experience at Brandon that commercial fertilizers are especially beneficial on soils able to retain a fairly high percentage of moisture and where the spring growth is normally backward. Different seasons and different districts will show quite a marked variation in response to fertilizer. The wet, cool spring and early summer experienced this year in Manitoba favored applications of ammonium phosphate; and fourteen illustration stations operated from Brandon averaged six bushels more per acre on fertilized than on unfertilized crops. The fertilizer was used at 35 pounds per acre and produced an increase as high as 12 bushels at Swan River; 9 at Dugald; 8 at Pipestone; 7 at Ericksdale; 6 at Hargrave, Goodlands and Lenswood, whereas at Boissevain, Crystal City, Gilbert Plains, Gunton and Lyleton the difference varied from 2 to 4 bushels per acre. At Arborg there was only one bushel difference and at Katrime, there was no increase this year at all.

Take Care of Manure

There seems to be no doubt of the fact that several times as much money is lost each year through the mishandling of barnyard manure as is paid out for commercial fertilizers. Each ton of barnyard manure contains about 10 pounds of nitrogen, 5 pounds of phospheric acid and 10 pounds of potash. This means that a ton of manure is equal, on the average, to 100 pounds of a 10-5-10 commercial fertilizer at the very least. Actually it is worth more than this, because, aside from the actual plant food contained, the manure has a beneficial effect on the soil by loosening up heavier soils and aerating them so that air, water, bacteria and the natural chemical activities of the soil can proceed more readily; and also by giving more body to lighter soils that need the addition of humus with its waterholding capacity and its generally beneficial effects.

It is calculated that half of the total nitrogen in farmyard manure is lost through leaching, as a result of insufficient bedding and fermentation. The best way to conserve these nutrient and other values of manure is to cart it to the field direct from the stables and pens. It can, on most farms, be used to best advantage on nearby fields. On farms where there is plenty of livestock, the manure is, and should be, hauled out daily and spread. Where there is less stock much time and un-

necessary labor can be saved throughout the greater part of the year by loading direct from the stable to the spreader or wagon and the load hauled as the spreader is filled.

Phosphates in Agriculture

Should increased profit be the sole factor in determining the use of phosphates? It is true that there is no other factor which may be served by the use of the commercial product. But are there any factors which may be cited as arguments against its use? There are about 138,000 farmers in the province of Saskatchewan alone. Many of these farmers have been piling up farmyard refuse on their farms for about 40 years on the average, and some of these manure piles contain a great many tons of fertilizer which, if applied to the fields, will give the increase which comes from the use of phosphates, and other useful and valuable results which do not follow the use of the commercial fertilizer. Why, then, not use the barnyard supply of fertility which has been going to waste for so many years?

The arguments against the use of the phosphates where manure is available are overwhelming. Foremost among these is the fact that the applications of manure provide a favorable medium in the soil for the operation of bacteria and fungi. Many of our soils which are entirely or almost entirely without the most necessary ingredient for productive soils—humus—do actually give increased yields of cereals by the use of phosphates, but they do not leave residues which are a factor in future abundance. They do, on the other hand, foster soil conditions which render the soil foreign to successive quality crops.

This is a difficult doctrine to present effectively to agriculturists serving, as always in the past, under the obvious economic injustices which beset them as limiting factors. But quality crops, and permanent agriculture are objects which should be served ahead of the profit-making motive, and these factors are inseparable from the use of common barnyard manure as the one essential soil amendment. The phosphate principle is a short range one only, to give it its very best recommendation.

There are a great many other factors which enter into the problem, scientific as well as economic, but the foregoing is one representing the facts found and the opinions expressed by leading soil scientists the world over.

Moisture Conservation

Save the Water

Most crops, according to A. E. Palmer, assistant superintendent, Lethbridge Experimental Station, can use water stored in the top five or six feet of soil. It is therefore, desirable to fill the soil with water to this depth, if possible, in the fall, so that the moisture supply will be there for the following summer. In irrigated districts this can be done by giving a fall irrigation, especially on perennial grass and legume crops. Such crops are irrigated at Lethbridge in September as a rule and as late in October as water is available. "There is little loss of water from the soil, between the fall and the time the plants start to grow in the spring," said Mr. Palmer, and in the experiments conducted at Lethbridge, "the soil has been found to be an efficient reservoir for storing water through the winter."

Where irrigation is not available, much can often be done to increase the supply of moisture for the spring crops. Trash covers or stubble prevent water from moving rapidly and thus allow it more time to soak into the ground. Cross furrows on sloping land serve the same purpose and hold more moisture in the soil that would otherwise escape down the slope. Anything that can be done before freeze-up to hold the fall water and winter snow for the benefit of next year's crops and to take care of the run-off in the spring, will pay good dividends if time can be found for it.

Ridging Snow in Prairie Fields

Judging by the results obtained by ridging snow in fields and the hundreds of requests for information on this subject, there is a tendency to put a wrong interpretation on the benefits from this work.

From a standpoint of yield, the largest and most consistent influence is on hay land. Perrennial and biennial grasses and legumes used for hay require spring moisture because these hay crops are harvested early in the summer. On the prairie, spring precipitation is usually low, and snow water soaked into hay land has greatly stimulated the growth of grass compared to a portion of the field where snow was not retained. Hay from sod two and three years old has shown greater increase than the first hay crop.

With grain crops, there is a limit to the results from spring moisture such as comes from snow accumulated on field. Grain is harvested in August, and its yield, for the most part, is determined by the amount and distribution of rain during June and July. When spring growth of wheat is stimulated by extra moisture, such a crop requires more moisture in midsummer than is required by a normal crop. Stubble in the fall has less moisture than summerfallow, and a moderately deep, even snow cover raises its soil moisture on a par with summerfallow. While accumulated snow on summerfallow, particularly when July is dry and hot, will not necessarily give increased yield of wheat, the extra spring moisture not only starts the crop but is a valuable help in facilitating the control of soil drifting—our greatest hazard in prairie agriculture.

Hundreds of farmers who have ridged snow on their fields are wondering now, in midwinter, if a second ridging should be given to accumulate more snow. The suggestion is offered that a second ridging be done only on hay land. A deep snow cover has its limitations for grain, and too much snow may be present when frost ceases at night so that its rapid disappearance may cause erosion on bare soil particularly on sloping land, especially in the Chinook area.—D. G. Mathews.

Row Crops Conserve Moisture

F. L. Quincke, assistant in cereal breeding at the University of Saskatchewan, is convinced that the extensive use of summerfallow in the growing of cereals is uneconomical and is due ultimately to be replaced by row-cropping.

The use of row crops should be used in connection with a rotation of wheat and oats, or wheat, barley and oats, in order to avoid certain diseases and insect pests. Perennial weeds should be cleaned up first, by summerfallowing, before row crops are grown; and on land subject to erosion, the rows should run at right angles to the slope of the land, says Mr. Quincke.

"The grain is sown in double rows six inches apart, with some fertilizer, if necessary. Two or three times as much seed is sown in each drill row as when seeded solid. The distance between the rows may vary from 24 to 36 inches, depending on the soil or climatic conditions. Cultivation of the land between the rows commences soon after the grain reaches the third leaf stage. The land must be kept free of weeds and may require three cultivations, the last of which should be given about the time when the grain grows into the shot blade. The grain is cut preferably with a combine and the stubble is left as long as possible. The combine must have a special weed cleaner to prevent the weed seeds from being scattered over the field. The straw is to be spread as evenly as possible over the ground.

"Soon after harvesting, the land between the rows should be torn open by spring teeth attached to the cultivator, with a coulter in front of each tooth to cut the straw. The soil, being ripped open, will be able to absorb moisture more readily, especially the water obtained from melting snow, while at the same time the straw is mixed with the soil and this will disintegrate more readily. During the winter the stubble rows act as a snow trap.

"In the spring after the soil has dried up sufficiently, and the volunteer grain

has germinated, a cultivator stroke is given between the stubble rows. About two days later, seeding can commence. This time the grain is sown exactly in the centre between the stubble rows, which remain standing as a wind protection for the young seedlings and also help to cut down the amount of evaporation.

"As soon as it is necessary, the cultivation should commence. It might be a good practice to work down, first, only the stubble rows over which the tractor wheel runs, leaving the remaining stubble rows for the second cultivation. This however, depends on the weed infestation, but in any case the space between the seeded rows must be kept clean. He believes we are headed towards "a combination of summerfallow and continuous crop, namely, row crops, grown year after year, with large scale machinery," as, he informs us, he has practised it successfully for years.

Forage Crops

We Need More Grass and Clover

Grass is an essential feature of any permanent type of agriculture involving the production of livestock. It is also an important factor in the agriculture of any area whose natural vegetative cover was, or is, grass. It is at least arguable whether any large natural grass area can ever develop a permanent type of agriculture, unless hay or pasture crops have been fitted into its economy in a substantial way.

Standard hay and pasture mixtures are recommended by each of the dozen or more universities and experimental institutions on the prairies and they are applicable in a general way to areas of variable size. Certainly they can be adopted by thousands of individual farmers with much more prospect of success than many of the catch-as-catch-can mixtures now used; but a fact of the greatest importance to the individual farmer is this, that the officials of these institutions would prefer to advise the farmer directly, after they have been made acquainted with the special conditions on the farm, which only the farmer himself knows at first hand. As a matter of interest, here, it can be said that of over 40 hay and pasture mixtures reviewed in the preparation of this article, no two were exactly similar. Each came recommended by one of these institutions, for some particular climatic, or soil condition, or for some special purpose.

Generally speaking, there are six cultivated legumes and ten cultivated grasses that have found some place in the economy of the prairie provinces. Alfalfa, white and yellow sweet clover, red clover (Altaswede), alsike and white Dutch clover are the legumes; and of these alfalfa is by far the most important. The grasses are Brome, Crested wheat grass, timothy, western rye grass, meadow fescue, Kentucky blue grass, creping red fescue, red top, reed canary grass and slender wheat grass, more or less in the order of their importance. Of these 16 legumes and grasses, alfalfa, sweet clover, brome and crested wheat grass are, with timothy, the big five among cultivated hay and pasture crops.

Thirty-six of the 40 mixtures already referred to, contain some alfalfa. The chief reason for this is that alfalfa mixtures maintain better yields during the summer months when grass grows but little. Alfalfa is a long-lived, deep-rooted perennial, very high in protein, able to withstand drier conditions than red clover or alsike, and is generally considered, when grown with brome grass, to be responsible for a higher yield of brome than if the latter were grown alone. Not as palatable as the better grasses, it is nevertheless, indispensable for all general hay or pasture purposes wherever it can be grown. As a pasture crop it bears one handicap in common with sweet clover, namely, danger to livesock from bloating. Generally this danger can be obviated if not more than a few pounds are used in the mixture and if care is taken not to allow hungry cattle and sheep to go on it early in the day before the dew is off. Bloating is more likely in some dis-

tricts than in others; and, too, it is probable that high-producing, highly-sensitive dairy cattle, requiring very large quantities of roughage, will bloat more readily than the more phlegmatic beef animals. Grimm and Ladak are the two alfalfa varieties in most general favor.

Brome grass is tops among the grasses for all general prairie conditions. It is high yielding, nutritious, makes a quick strong growth the year of seeding, is very succulent (and therefore easily damaged by frost), forms a fairly dense sod and withstands tramping by stock, or rooting by hogs, as a result of its creeping rootstocks which enable it to fill in bare places. For the same reason it is valuable for holding weeds in check Common brome is more widely preferred in the Scott area than Parkland, chiefly because it requires less seed per acre, makes a stand more rapidly and is more vigorous. At Brandon, however, Parkland brome is preferred in mixtures with alfalfa on account of its less aggressive root system; and yields with Parkland have been higher there than with common brome.

Crested wheat grass is the third most valuable forage crop on the prairies This is due to its drought resistance and its ability to establish itself in drifted and light, sandy soils. Its root system is remarkably fibrous and at the Laboratory of Plant Ecology, Saskatoon, a single mature crested wheat plant has been found by actual measurement to possess a root system, which, if extended in one line, would reach for 315 miles. It is not as nutritious, nor as palatable as some other grasses, but even under Parkland conditions small amounts in the regular mixtures may prove advantageous, owing to its early spring growth and the fact that it is superior to brome for fall and winter grazing. It has been successfully used in many cases for controlling weeds, but in midsummer, probably as a factor in its drought resistance, it tends to dormancy and is not so aggressive a competitor with weeds.

The two types of crested wheat grass are the common, or forage type, and Fairway. The latter is leafier, finer in the stem and yields equally with the forage type in Saskatchewan generally, but the common grows taller and the seed is easier to handle, while it has less tendency to go dormant during the hot season. Saskatchewan authorities state that crested wheat grass hay, when cut at the proper time, is superior in feeding value to brome or timothy; but it should be noted that its protein content drops quickly after heading.

As a general rule, the time of seeding, and whether a nurse crop is advisable, are governed primarily by moisture conditions and partly by weed control. Recommendations for different areas vary quite widely as illustrated by the Scott area where (1) fall seeding, (2) seeding in late May on harrowed and packed spring plowing, and (3) seeding on partial fallow in the latter half of May, are each recommended for different cereal zones. Throughout all this area, seeding to grasses and legumes means loss of revenue from the land for one year since no nurse crop is advisable. In many parts of the west, early fall seeding of crested wheat grass gives good results, provided ample moisture is available; otherwise, seeding must be delayed until just before freeze-up.

Seedings without a nurse crop give quicker results in the Peace River area, but more economical results there on land inoculated for legumes usually come from the use of a nurse crop of Olli barley. The University of Alberta recommends shallow seeding from mid-May to June 30, by drilling and packing, without a nurse crop. Lacombe recommends seeding alfalfa combinations from June 8 to 15, without a nurse crop, but for the parkland and grey-wooded soils, early spring seeding with a nurse crop is preferred. Flax is a poor nurse crop, except on clean land. Tall, leafy crops are best. In parts of Saskatchewan, seeding before the wheat is sown, into trash, stubble or weeds, is recommended for brome, western rye, or crested wheat; but in areas where annual weeds are troublesome, such as at Beaverlodge and in the Carrot River Valley, this method is not considered advisable.

It is generally agreed that crested wheat, alfalfa and sweet clover should be seeded not more than ¾-inch deep

and preferably half an inch. Brome and western rye grass may be seeded slightly deeper. The Dominion Forage Crop Laboratory, Saskatoon, finds that crested wheat and western rye will flow through the drill, but advises that brome, sweet clover and alfalfa should be mixed with cracked grain where no nurse crop is used, as in that area. Morden and Melfort recommend broadcasting and harrowing in the grass and legumes, even where a nurse crop is used.

Hay and pasture mixtures, as already intimated, vary so much that even to give representative mixtures here would be of little value. Practically all mixtures can be built up on from 2 to 6 pounds of alfalfa and 4 to 14 pounds of brome, or 3 to 10 pounds of crested wheat grass, according to the area. The University of Manitoba recommends brome and meadow fescue for eastern Manitoba; Lacombe recommends a mixture of timothy, Altaswede and alsike for grey-wooded soil, or moist, alkaline locations, or for a one-year soil improvement sod; while the University of Alberta recommends timothy, Kentucky blue and Altaswede as a hay crop for Edmonton and moister areas; also, 4-5 pounds of Kentucky blue and 3-4 pounds of white Dutch clover for pasture in the same area, where the pasture can be kept short. Unless such a pasture is kept short, the white Dutch will die out in a year or two.

A word should be said about spring-flooded or ponded areas. Much work has been done at Swift Current in this connection and it has been found that alfalfa and sweet clover will stand water for about ten days, alfalfa a little longer than sweet clover. Red clover, crested wheat grass and Kentucky blue grass will survive, except for slight damage, after two weeks. Alsike and timothy will stand three weeks with scarcely any damage and reed canary grass a month or two. This grass is a hardy, long-lived perennial, with large, creeping, underground rootstocks and will produce hay of good quality if cut just as heading begins. It will not tolerate much alkali.

Only two per cent of the cultivated acreage of the prairies is now devoted to hay and pasture crops and this amount could well be multiplied several times, even after allowing for very large areas where wheat growing will probably continue to occupy the chief energies of farmers.—H. S. Fry.

Millet for Light Soils

Millet varieties can be classified as of two general types, distinguished by the general appearance of the seed-head. The fox-tail, or hay millets, such as Empire and Siberian, are so-called from the fact that their seeds are borne in a rather dense, cylindrical spike, while the Proso, or grain millets, like Crown, Hansen's Proso, Red Turghai and Hog millet, possess a more spreading panicle-type of head. Empire and Crown are both varieties that have been produced by the Dominion experimental farms. Empire is a heavy yielder of hay, but it matures about two weeks later than Crown, which is the variety recommended for Manitoba by the Dominion experimental farm at Brandon.

M. J. Tinline had this to say about millets: "We have grown Crown at Brandon for eight or ten years, but some millets have been grown here for the last 50 years. Until recently, very little millet has been grown on farms. A few farmers grew it occasionally in dry years, on light soils. It was, in fact, always regarded as an emergency crop at Brandon, but we have found that millet grown for hay fits particularly well into the light soil areas, especially in years when the hay crop is likely to give poor returns. Millet tends to spread out the seeding season, because farmers can take a piece of land after the remainder of the seeding is done, sow it to millet and in ordinary years get a crop of hay. In dry years the crop is doubtful of course; but there is another advantage, in that millet is perhaps the last crop to be attacked by grasshoppers, probably because of its hairiness. This, incidentally, is something of a disadvantage, when considering millet as a fodder feed for livestock. It can be said for millet, however, that in dry areas millet stubble is more resistant to decay than grain stubbles, which makes it a better trash cover. Where it is grown for grain, however, it tends to dry out the soil to a greater extent than where

grown for hay, owing to the fact that it is about a month later in maturing. At Brandon last year, we cut our millet for hay on August 9 and the grain millet was harvested September 10."

Asked about yields of grain and hay, Mr. Tinline pointed out that yields varied considerably. Yields at Brandon, he explained, were hardly representative of the average for the province. In this respect yields at Melita were a safer guide. Where Empire was regarded as the most satisfactory variety of millet for hay, at Morden, and Crown, where grain was desired, Mr. Tinline said that at Brandon they were recommending Crown for general use, because in so many cases farmers who sowed millet did not know, until late in the season, whether they would harvest it as hay, or leave it for grain. Consequently, Crown, though a little coarser in the stem than Empire and Siberian, was decidedly finer than Hansen's Proso, Hog or Red Turghai, and was definitely the most desirable variety for grain.

At Brandon, Crown had yielded nearly 62 bushels per acre in 1940 and an average for the last three years of 57 bushels. At Melita, it had averaged 37 bushels for the last three years. At Morden, where high yield of grain were secured last year, Crown yielded 52½ bushels per acre, while Hansen's Proso returned 33.8 bushels and Empire only 22.6.

Yields of millet for hay also vary considerably. For example, Empire, at Morden, yielded 3.28 tons of dry matter per acre, which is a different thing from yield expressed in terms of hay. At Brandon, where the yields were on the latter basis, Crown yielded 3.1 tons per acre for the last four years, as compared with 3.22 tons of oat hay. At Melita, has averaged 1.9 tons for the last two however, where the yields might be considered as more representative, Crown years and oat hay 1.4 tons.

"When grown for hay," according to Mr. Tinline, "millet should be cut as soon as it is headed. It is also worth noting that the ordinary farm machinery can be used for seeding and harvesting. The objections to the crop are that millets are frost tender, both in the spring and autumn, and should not be sown before mid-May. Cut for hay, they are somewhat more difficult to cure than grass or grain hays and the young plants do not withstand soil drifting. Notwithstanding these disadvantages, the acreage sown for grain is rapidly increasing in the light soil areas, where oats and barley have given poor yields."
—H. S. Fry.

Wild Bees and Alfalfa Seed

Investigations by the Dominion Forage Crops Laboratory, Saskatoon, seem to indicate that the setting of alfalfa seed is largely dependent on the presence of wild bees of the leaf-cutter type; and that these bees manage to trip a much larger percentage of the alfalfa blossoms in their rapid movement from flower to flower, than do other insects. A large number of fields visited in the White Fox area in northern Saskatchewan during the past two years, led to the conclusion that pod setting in these fields was directly related to the number of leaf-cutter bees present.

It is pointed out that honey bees rarely trip alfalfa flowers. Even flowers tripped by hand, form only about one-sixth as many seeds as those tripped by leaf-cutter bees. These are more commonly found in areas where cultivated land is surrounded by stump or other waste land and they seem to prefer nesting in logs and stumps of the Balsam poplar.

Sudan Grass for Late Planting

Not the least of the advantages of sudan grass, is that it is not as particular as some crops about the type of soil it is grown on; and it has the further important advantage, as a pasture crop during the hot months of July and August, that it will, under anything like normal conditions, provide green pasture when other grasses may be dry and brown.

It should not be sown early. After the ground has warmed up, from the latter part of May until the middle of June, is the best time; and the seed bed should be fairly fine and firm. For the purpose of pasture, seeding should be at about 20 pounds per acre in drills six inches apart. If an ordinary grain drill is used,

this will mean setting the drill at a little better than two pecks per acre.

The crop will be ready for pasturing about four or five weeks after planting. If the stock is removed after the first growth is eaten off, it will come on again and the stock can be returned to it. After it has been frozen down in the fall, stock should not be allowed to eat it, as it is then poisonous. Similarly, if it is to be grown for seed, it should not be grown closer to other sorghums than 60 to 80 rods, owing to the fact that it hybridizes freely with them and the resulting seed produces grass that is poisonous to stock, especially during the first weeks of pasturing.

"Although sudan grass is a high yielding palatable grass, it is considerably more valuable as a source of succulent mid-summer pasturage, than as a source of hay. Sudan grass is hard to cure for hay even in hot dry weather. This is especially true if the yields are heavy. Owing to the coarseness of the stems, they do not dry out as quickly as the leaves, and unless care is taken, the hay may be stacked or placed in the barn before it is dry. If sudan grass is not dry when stored, or if it becomes wet from rain, or other moisture accumulations, it not only is apt to mold, but it may develop other poisonous qualities.

"The prussic acid content of sudan grass is not materially affected by drying. Sudan grass which is poisonous at the time of cutting, will be poisonous if fed as hay or silage. However, there is little or no danger of prussic acid poisoning, to livestock fed sudan grass hay, because cutting is usually deferred until the plants are two feet high or higher. The prussic acid content of the plant is very low at this advanced stage in its development. The poisonous qualities which may develop in improperly cured, moldy sudan-grass hay, are not the same as prussic acid poisoning."

Better Quality Hay

Cutting hay is too often delayed till the heaviest tonnage can be obtained, whereas hay cut early frequently contains 20 per cent more total digestible nutrients than hay cut in the late bloom or early seed stage.

Good hay should carry a high percentage of leaves and should have a natural green color. The stems should be small, pliable and sound and there should be a good aroma to the hay.

In catchy weather the handling of hays becomes an art, if one is to get quality hay. Further, a wise haymaker will not do his cutting so that the grass is left open to cure over the weekend. Farmers used to catchy weather, as in the east, or Great Britain, are anxious once the hay is down. Unfortunately, some will try shortcuts in the handling, which invariably result in loss of quality perhaps of the entire crop.

So many used to handling prairie wool and slough hays gave comparatively little thought in the dry seasons to rendering the hay safe against spoiling; and as soon as fairly dry, it was raked into windrows and the rake again used very soon after, up and down the rows, to "bunch" it. The good cultivated hays will be spoiled by such rough treatment; and if the weather turns bad—well, it's worse. These open bunches let in the rain or showers and delay one far longer than if the windrows had been properly cocked or coiled by hand. The coils, if properly put up, from rows made preferably by a side-delivery rake, will stand showers without spoiling. They will come through heavy rains with a minimum of loss of both quality and time.

The valuable hays need time to cure properly. It is not safe to have the curing take place in a barn loft and it is even risky in a stack. In the coils, if not fit to stack or put in a loft or mow, it is comparatively safe to leave for some time longer.

Cutting and Curing Alfalfa

The younger the plant the higher the content of protein. For this reason it is desirable to cut forage crops as soon as it is economical to do so from the standpoint of yield. Cut when the plants are too young, the yield is decreased, so that, in the case of alfalfa, it is considered advisable to cut the crop when the plants are about ten per cent in bloom. Two cuttings can generally be secured and sometimes a third, but unless it has been proven a safe practice

in the district, a third cutting is unsafe, since it often results in winter-killing.

Curing alfalfa hay is simply a process of drying it out with the smallest loss of leaves and the maintenance of the maximum amount of green coloring in the leaves. The moisture must be reduced from about 75 to about 20 per cent before it is safe to store the crop. The problem is made more difficult because the stems dry out more slowly than the leaves and the latter are likely to drop off the stems before these are sufficiently dry. On the prairies, the weather is relatively dry and curing a simpler process than in regions of heavier rainfall.

It is advisable generally to cut the crop in the morning and let it wilt for four or five hours before raking it into windrows. Using a side-delivery rake and only about two swaths to each windrow, the leaves have a tendency to roll into the centre of the windrow, leaving the stems sticking towards the outside. This is as it should be and tends to retain the coloring of the leaves and keep them clinging to the stems. After one or two days, depending on the weather and involving perhaps one turning with the rake, the hay should be ready for storing or stacking.

Harvesting and curing practices will vary in different areas, but the end to be achieved, if at all possible, is to dry the plants sufficiently, with little or no loss of color or leaves.

Good Feed Value in Russian Thistle

The Russian thistle, it is pointed out, while not a true thistle, gets its name from the fact that the leaves of mature plants have sharp spiny tips. In the younger plants the leaves are fleshy and readily eaten by cattle or sheep. Also, analyses of Russian thistle show that young plants compare favorably with alfalfa, but with most other plants, the protein content drops off rapidly as maturity approaches. Consequently it is very important to cut Russian thistle before the plants become mature. The crop can be stacked and, while it will turn black in the stack, this does not impair the value of the feed. Salt can be added, if desired, as stacking progresses.

Molasses Silage

One method of preserving early cut hay and of saving hay in catchy weather is to ensile it, using molasses, which help to preserve the feeding value.

To make molasses silage, cut a legume-grass mixture early, before bloom and not later than one-tenth bloom, draw it in directly it is wilted and cut it as fine as possible, adding 60 pounds of molasses per ton of green fodder as it is being fed into the cutting box. Tramp firmly in the silo to exclude air and prevent spoilage. The ensiled crop should have a moisture content of approximately 70 per cent.

The advantages of making some molasses silage from early cut hay are:

1. Well preserved legumes grass silage makes good feed. It is usually higher in vitamins, protein and mineral content than corn.
2. It can be fed to the herd during the dry, hot July-August period to advantage when pastures are short, or carried over for winter feed.
3. There is usually a good aftermath following the early cutting, especially if alfalfa and the drought-resistant grasses, orchard and brome, are used in the mixture. This can be utilized for pasture to advantage during the late summer season. The grazing should be controlled by the use of electric fences.
4. Distributes the labor of haying.

Ensiling Hay Crops

Corn, sweet clover and sunflowers are the standard silage crops on the prairies. A Wisconsin bulletin outlines methods of ensiling other crops with good results. It is possible to make good silage out of alfalfa, red clover, oats, soy beans, Sudan grass and timothy, and the list could include brome grass.

These crops will not keep well, it is explained, if they are not put up with some sweet or acid preservative. They are cut a little earlier than for hay and ensiled immediately. The most popular preservative is molasses, applied at the rate of 60 pounds per ton of alfalfa. Phosphoric acid is also used, the rate being 15 pounds per ton. It is more expensive than molasses but it brings

up the phosphorus in the ration and improves the quality of the manure. A home grown mixture, consisting of 150 to 250 pounds of dry corn and cob meal to the ton, is also used. It preserves the silage very well and improves the taste. The Finnish method, which uses sulphuric and hydrochloric acids, is one of the best but is expensive and the acids are corrosive and have to be sprinkled on the material in the silo.

Manufacturers are providing new machinery to handle this kind of silage crop. A heavy duty loader that will handle green hay is on the market and a molasses pump attachment can be purchased for the ensilage cutter.

Measuring Hay in Stacks

In selling hay it is seldom convenient to weigh it to obtain actual tonnage. Failing means to ascertain the correct weight we resort to estimating the volume by a rule of measurement and further estimating the number of cubic feet necessary to equal a ton of hay.

There are various rules for arriving at the volume in cubic feet and the weight is usually calculated on the basis of seven feet to the ton or eight feet to the ton, meaning of course a cube seven feet to the side or eight feet to the side as the case may be. Cubing seven feet gives us 343 cubic feet and the figure generally used is 350. Eight feet cubed gives 512 cubic feet and the figure used is 500.

In Montana an agricultural engineer made a carefully conducted investigation of nearly 300 stacks of various kinds of hay. His findings are of interest to those who buy and sell hay by measurement.

All hay investigated by him was stacked with either an over-shot or a swing stacker. The first important finding is that the average shrink in volume of all stacks is about 25 per cent in 30 days. Alfalfa shrunk a little less than other hays. The shrink for the second 30-day-period was five per cent and after that nil for the next four months. After six months the volume began to shrink again, losing another 10 per cent by the end of 12 months.

The shrinkage is important in estimating the cubic feet per ton. His findings show that the weight per cubic foot is extremely variable in any kind of hay. In native hay it varied from 1.93 pounds to 4.14 pounds; in alfalfa from 2.32 pounds to 5.78 pounds. The average for all stacks was about 3.5 pounds, which requires 571 cubic feet to equal one ton. At three pounds the volume required would be 667 pounds and at four pounds the volume would be 500 pounds.

In arriving at the volume, the length and width are easily measured, but some rule must be used to get the heighth. He found the most accurate simple rule to be: heighth equals overthrow minus five-sixths of width divided by two. Thus we have the formula LxWx (O-5/6 W) ÷2. At first glance the formula looks complicated. It is really quite simple and we think worth knowing if you buy or sell hay in the stack.

Those either buying or selling hay in large quantity by estimating tonnage would do well, for their own information, to go to some trouble to estimate a few stacks of various qualities and check the results by putting the hay over a scale.

Another Method

Pace off length and breadth of stack in yard paces. Estimate the height against your own, allow a little extra for the sloping roof; say one-third of the upper part, where there is a good even slope with gable ends.

For example, paced stack is 10x5x(say 10 ft.) or 33 yards=167 c. yards. Very light, dry made hay where you can easily thrust in the arm to the shoulder would weigh at the outside only about three-quarters of a hundredweight to the yard. A well-made stack of clover, standing at least a year will become so dense that you can hardly put your hand in or perhaps only the fingers. This would weigh at least two hundredweights to the yard. Say 167 c. yards at ¾ cwt.=only 6 T. 12 cwt.

The same at 2 cwt. would be as much as 16 T. 14 cwt. Skill at this depends on ability to judge density by thrusting the arm into the stack at various places.—Francis J. Coombs.

Effective Use of Pastures

Making the best use of pastures is an economy deserving more attention than it receives. Grazing two or more pastures in rotation is a plan followed by many good farmers. They realize that two classes of stock such as sheep and cattle, will do better if one follows the other, than if both use the pasture at the same time. Sheep will crop closer than cattle and if the cattle are moved to another pasture, or to another part of the same pasture, divided by a fence, the sheep will clean up where the cattle leave off and the pasture will grow a fresh crop of young succulent grass, to be cropped again by the cattle when it has sufficiently advanced. Similarly, where there are a number of heavy producing cows in the dairy herd, these can be turned into the fresh pasture and moved to another when they have taken the best of it, leaving the remainder for the dry cows and young stock. Where rotation grazing is practised, such crops as fall rye, brome, brome and alfalfa, sweet clover, alfalfa, oats and rye, rape, reed canary grass and sudan grass can be arranged to suit conditions in various parts of the country, so as to follow each other throughout the season and provide continuous pastures of good quality.

Pastures that are too large for the number of head ranging on it are wasteful. The animals are bound to leave certain portions of the field untouched. Some at least of the grass matures so far as to become less palatable and less nutritious. Carefully moving the stock from one field to another economizes on pasture and makes for greater succulence and palatability.

Getting the Most From Pasture

M. J. McPhail, superintendent of the Dominion experimental station, Melfort, Sask., offers the following suggestion for utilization of pasture grass to best advantage in that area:

"A marked saving in feed could be effected if the pastures were divided into two parts, for, during most seasons, only a part of the pasture required to carry the stock through the summer is needed until on into July. When they have access to the whole field from the start of the season, a considerable portion heads out and gets so coarse that the stock simply leave it and may overgraze other sections. If it were divided, the stock could be confined to one part until a cutting of hay had been taken off the other and during the latter part of the season they could be allowed the run of the entire pasture, when growing conditions were not so favorable.

"There is not much doubt that this plan would be advantageous in almost all areas. This has been demonstrated by a ten-year trial conducted in South Dakota. In this case no hay was taken off any of the land and it was found that the alternate pastures on an average produced six per cent more beef per acre than the continuously grazed areas."

Overgrazing of Pasture

Overgrazing is a very easy mistake to make, but once made, it may require several years to repair the damage and bring the carrying capacity back to what it was. The establishment of the Dominion range experiment station at Manyberries, Alta., has already resulted in the discovery of a great deal of invaluable information of service to ranchers. Land that will produce an average of 270 pounds of air dry grass per acre will carry one head per 50 acres, while to carry one head on 30 acres, needs a grass crop of 450 pounds of forage annually over a period of years.

Grazing should not be severe enough, however, to eat off all of the crop produced. Successful ranching requires that at least one-third of the palatable current growth must be left on the ground at the end of the season. This apparent waste not only provides feed insurance for the lean years, but holds snow and moisture, prevents so much evaporation from the soil, makes an ideal feed in the early spring when the new watery growth is getting started, reduces erosion of the soil by retarding the run-off of water, and provides a reserve of feed which makes it less necessary to frequently adjust the number of head allowed to pasture.

The carrying capacity of severely burned over land is seriously reduced

and experience has shown that where fire has burned range land, the second time within three years, a great many weeds creep in and establish themselves before the grass can be brought back to sufficient strength to compete. Low-lying, flat land, under such conditions, will be taken over by broomweed, poverty weed and globe mallow; and the grass on higher land will suffer severer competition from prairie sage and globe mallow. Whether the fire occurs in spring or autumn does not seem to make much difference and full recovery from a single fire is difficult inside of three years.

Sweet Clover as Pasture

Sweet clover is one of the best farm pasture crops over a large part of the prairies. To secure best results from sweet clover, it should be pastured fairly early in the season, since the stock then eat off the tops of the plants before they have advanced too far and the plants then branch out more freely. This results in an increase in the proportion of tender succulent growth and decreases the number of coarse, heavy stems. Care should be taken in the use of sweet clover for pasture to have a sufficient number of animals in the field to keep the growth down and prevent the stems from becoming coarse.

Sweet clover is less likely to cause bloating than alfalfa. It is, however, unwise to turn animals into sweet clover, or alfalfa, when the clover is wet, or when the animals are hungry. A good feed of dried roughage of some kind just before they are turned into the sweet clover will probably guard against any tendency to bloating.

Rejuvenating Old Fields of Brome

While visiting the Dominion experimental station at Lacombe, Alta., we were shown two fields of grass that had been down to brome grass for perhaps ten years and had become so very thin that it was a question of rejuvenating them in some way or plowing them up. One of these fields was on the experimental farm and the other was on an adjoining farm.

One field was double-disced thoroughly in the spring and the brome on the surface broken up pretty fine and the field made fairly black. Sweet clover was then sown and a very fine catch secured. This was in the spring of 1940. The field was pastured in the fall and when we saw it early in June there was a fine, even stand over that portion of the field we looked at and some of the clover was at least ten inches high. The brome was coming along and appeared to be in vigorous condition in spite of the fact that the spring had been the driest on record for many years in that locality, until some rain had come about ten days before.

The other field in a similar condition had been given different treatment. It had been plowed with a tractor very early in the spring before any of the other land was fit to work. The plowing was about 4 to 4½ inches deep and the soil after being worked down to seed-bed condition, was sown to alfalfa. Contrary to expectations, this treatment, while resulting in a fine catch of alfalfa, had not had the desired effect on the brome, possibly because the plowing was done too early in the spring, or perhaps because the plowing may have been a little too deep, or both. In any case a lot of the brome appeared to have been killed out, whereas other brome similarly treated in previous years had come back in fine style and the treatment had efficiently revived brome grass of several years standing which was getting too thin to be profitable.

Checking On Brome Grass

An experimental check on the yield of brome grass as pasture, in comparison with timothy and Kentucky blue grass has been made by the agricultural experiment station at the University of Wisconsin. Small areas or plots were used and sheep were turned into them when the grass reached a height of two to three inches on some plots and from five to eight inches in height on others. Yields were determined by placing wire cages over sample areas selected at random on the plots.

The yield of common brome grass increased 18 per cent when it was allowed

to reach five to eight inches in height, as compared with allowing it to reach the hay stage. By comparison, Parkland brome and timothy yielded less. The decrease in the case of timothy, was 41 per cent, and Parkland brome, 14 per cent.

Grass for Seed

"From the standpoint of the farmer who is considering the possibilities of grass seed production, it may be taken for granted that there are relatively few individuals who will find it congenial to produce grass seed annually, as a specialty."

The statement just above comes from Dr. L. E. Kirk, dean of the college of agriculture, University of Saskatchewan, and one of the best known advisers on the subject of forage crops for the prairies. It is a sound warning to all those people whose tendency is towards over-enthusiasm, but it should not be taken as discouraging by those individuals who have been growing grass seed during the past years, with some success. In fact, the reverse is actually the case, for Dean Kirk also expressed the following opinion:

"I think we should recognize that our climate is ideally suited to the growing of grass seed. Grasses require a cool climate, with sufficient moisture to fill the heads of the grasses. These conditions become more favorable as we proceed from southwest to the northeast sections of the province. Hence, in the case of Crested wheat grass, for example, there is a differential in the annual yield, of several hundred pounds per acre. Under favorable conditions in southwestern Saskatchewan, Crested wheat grass may be expected to give an average yield of 100 to 200 pounds per acre, while in the Carrot River Valley, an average yield of 500 pounds may be expected, with an upper limit of 800 to 1,000 pounds. At Saskatoon, about 300 to 400 pounds is a safe estimate. Conditions as favorable as in the park belt, are comparatively rare south of the international border."

Begin Slowly and Keep Growing

"Do not undertake more than you can handle properly. A great many failures and much discouragement is caused by going into the grass, or alfalfa seed business, on too large a scale. There is much to be learned and attention to detail is necessary. It is much better to attempt only what can be handled properly; and consistently grow, each year, a modest acreage of grass for seed. Only in this way can one obtain profitable returns and establish a reputation as a steady source of supply of seed of high quality."

Dr. W. J. White, in charge of forage crops at the University of Saskatchewan, discussed certain problems in the production of forage crop seeds; and dealing particularly with Crested wheat grass, offered the following modified recommendation with regard to seeding practice:

"Crested wheat grass has commonly been grown for seed, in rows 30 to 42 inches apart and cultivated between the rows. This procedure was recommended and practised because the rows remained productive over a longer period of years than the solid seeding, that is, in drills six inches apart.

"Given a moderate moisture supply, the solid seedings yield quite well, but when the stands are a few years old the seed yield is non-existent in a dry year, whereas properly cared-for rows will yield a satisfactory crop. However, the rows present their problems. They are difficult to harvest, due to lodging and the roughness on crossing the rows, and when plowed up, they do not give an equal distribution of the root fibre. Probably the greatest problem with rows is the amount of cultivation that is required to keep the weeds and volunteer plants in check. Unless the weeds and volunteer plants are kept down, the rows are no more productive than the solid seedings. On small acreages, the cultivation can probably be handled satisfactorily, but when the acreage becomes large it is a problem, unless special, large-scale equipment is available.

"Probably some compromise between the row and solid seedings would be worth the seed grower's consideration,

especially at these times when you are facing a labor shortage and higher-priced labor. I believe that by seeding in rows 12 to 14 inches apart, at about five pounds per acre, the grower can offset some of the disadvantages, but retain several of the advantages of the wider rows.

"About the second year after seeding, the 12-inch rows will, generally, pretty well control the weeds, and will also control the volunteer seedlings fairly well. Such weed and volunteer growth as does exist, may be taken care of by the spring-tooth, or disc harrow, with less cost than the narrow cultivator. These 12-inch row seedings, I feel confident, would be reasonably productive, particularly if the snow-plow were used on them to accumulate snow."

Harvesting Grass Seed

THE firmness or stiffness of brome grass seed is probably the most accurate measure of the state of maturity. This character may be easily tested by holding seeds, one at a time, endwise between the thumb and forefinger and gradually applying pressure. Immature seeds are soft and crush or buckle with the slightest pressure while the completely ripe seeds are hard and brittle and will break if sufficient pressure is applied. Seeds at the proper stage for harvesting are fairly firm and will bend but not crush or break under reasonable pressure.

Ease of shattering may also be used as an indication of the stage of maturity. This may be determined by striking the heads against the palm of the hand. Some seed will shatter when the crop is at the proper stage for cutting. If the crop has already begun to shatter its seeds, it should be cut at once.

Crested wheat grass should be harvested as soon as the crop is mature, otherwise losses from shattering will be heavy. During ripening the heads and upper part of the stems gradually turn a straw color. The proper stage for harvesting is reached when the heads are straw-colored but still show a slightly greenish tinge. The seeds are then in the late dough stage and are plump and firm but not hard. When pressed endwise the seeds will buckle rather than break.

The ease of shattering is another indication of maturity in Crested wheat grass. This may be tested by striking the heads against the palm of the hand. If the seeds are easily knocked out the crop is ready, or nearly ready, for harvest. When harvesting can be done promptly and quickly the crop may be permitted to stand until the seed just starts to shatter of its own accord.

Both brome grass and Crested wheat grass are normally green and leafy when the seeds are mature. The binder should therefore be set to make comparatively small sheaves which are tied fairly loose.—Agricultural Supply Board.

Harvesting Crested Wheat Grass Seed

If allowed to become too ripe, a large proportion of the seed, perhaps as much as 75 per cent, may be lost through shattering; and this must be avoided by cutting when the heads are well turned, but while the stems are still green. The Dominion experiment station at Scott has had a great deal of experience in handling Crested wheat grass during the last few years and it is suggested there, that a good guide is to press a kernel end-wise between the thumb and forefinger. If the kernel buckles rather than breaks or flattens out, the seed is ready to cut. The time of cutting is the latter part of July, or the first part of August.

Experience at Scott indicates that a combine is unsatisfactory for harvesting this crop, owing to the danger of shattering. A grain binder is more suitable for the purpose, where the crop has been seeded in rows as is customary for a seed crop. It is also suggested that a smooth, rather than a sickle knife should be used; and if the crop is unusually heavy and the heads bend over, special guards may be used to pick up the drooping heads.

Every effort should be made to save as much seed as possible. The following hints are the result of experience at Scott: "If the crop is too short to permit of tying in sheaves, a special box, as used for a short grain crop, will be

necessary. Considerable seed can usually be saved by spreading the canvas on the bundle carrier. It is also advisable to have the sheaves lifted off the bundle carrier, rather than dumped. Another consideration to avoid shattering is to cut Crested wheat grass in the early morning, rather than in the hot part of the day.

"Stooking of sheaves should be done immediately after binding. Long, narrow stooks, running north and south, are advisable. Eight to ten sheaves make a convenient size of stook. The stooks should be capped if some form of stook cover is not available, to prevent loss from rain or hail. The crop should be threshed as soon as possible after curing, which takes about ten days of fine warm weather."

Recommendations from the Dominion experimental farm at Swift Current are slightly different, probably because there is not the same danger of excessive shattering of the seed. C. G. Downing of that station advises that Crested wheat grass may be either straight combined, or swathed and combined with a pick-up attachment. "Where the growth is uneven," he advises, "it is advisable to swath, allowing the crop to dry out in the windrow. Swathing should commence when the heads are about one-third to one-half brown, or ripened. Swathing may be done with a converted binder, swather, or mower and side-delivery rake. With the latter method there is danger of raking stones, or other debris into the windrows. The cylinder speed should be about standard for wheat, with a minimum of concaves. This allows the heads to be cleaned of the seed, but the stems are not broken too finely. Very little air blast is necessary and the adjustable sieves should be about one-third open."

Harvesting of the grass seed commences as soon as the heads have turned brown. If the ripening is uneven, the start may be delayed a few days. For swathing to best advantage, the grass should be about fourteen inches long or taller. It was found that swathers operate as successfully for Crested wheat grass seed as they do for grain, but the swather lays a more satisfactory swath in a good heavy crop. Mr. Matthews informed us that where the grass is from two to three feet high the swath is almost perfect; and where the grass is clean, the swaths do not roll over, even though wind may come of moderately high velocity.

Experience in 1941 showed that a fast moving knife and reel was best and a very satisfactory speed is three and a half miles per hour. Where rough land is encountered, the self-propelled machine shows up to advantage, since the speed of the knife is maintained, though the speed of the machine itself may be slowed down. Little trouble is experienced from a gumming up of the knives unless the grass is quite green; and it was noticeable that in fairly heavy growth, a centre-delivery swather was more satisfactory, since the swaths rested more satisfactorily across the stubble, owing to an excellent interweaving of the stems and heads. Experience proved that anyone accustomed to the use of a swather or combine in grain could get good results in Crested wheat grass, although the reels must be set slightly lower than for grain and a little farther back.

Combines with rub-bar cylinders were somewhat more satisfactory than spike-tooth cylinders, because the latter tended to break up the straw to a greater extent and thus tended to overload the sieves. Less wind is required than for grain and slow and even feeding is best, since over-feeding resulted in crowding the decks and chaffer, with the result that some seed was carried over with the straw.

Crested wheat grass seed is so light that it was found advisable to cover the tops of the combine hoppers as well as the trucks hauling the seed from combine to freight car, with canvas or tarpaulin. A two-ton truck was able to haul the eight tons of seed from three 16-foot combines a distance of five miles in a twelve-hour day. To do this, however, it was necessary to increase the truck load from 2,600 to 3.200 pounds, by raising the height of the truck box, and to load in the field each time from the same convenient point. A blower loaded the seed directly from the truck to the car. Seed was fed to the centre of the fan and distributed throughout the car without shovelling, as fast as it could be shovelled to the blower.

Seed and Seed Cleaning

What Dirty Seed Means

THE Field Crops Commissioner of the Alberta department of agriculture recently gave a splendid illustration of the value of using clean seed He quoted an example of a farmer who had grown alfalfa seed which he proposed to use on his own farm. The seed contained some weed seeds, but the farmer was surprised to find, when the number of weed seeds were counted from a measured ounce of the seed he proposed to sow, that he was planning to sow 26,600 weed seeds to the acre, along with his alfalfa. In other words, the alfalfa seed which this farmer thought was good enough to sow, contained 380 weed seeds per ounce. Some of these were bound to be seeds of noxious weeds which he was no doubt endeavoring to get rid of by expensive methods of cultivation, yet he was about to re-seed his land to some of these very same weeds.

It pays to make sure that seed is clean. It may mean time and trouble to clean the seed grown on the farm and it may cost a little more to buy registered, or certified seed (which comes in sealed sacks) and can contain not more than a known maximum number of weed seeds. The extra time and money involved in cultivating weeds out of the farm year after year, however, will much more than pay for the time and trouble of cleaning seed well before using, or of buying registered or certified seed at a slightly higher price.

Losses from Impure Seed

W. T. Burns, of the Dominion experimental station, Melfort, describes the effect of seed mixtures.

The varieties of cereal grains recommended for general use are superior in yield to those they have displaced. Mixtures of the new and the old are not likely to give the highest yield. Some varieties, such as Banner and Victory oats and O.A.C. 21 barley, have been in use for many years. Many farmers have grown these crops from the same seed year after year without giving any thought to maintaining the purity of their seed. Such seed is very likely to have produced off types and become mixed to such an extent that it is inferior in yielding capacity to the original stock.

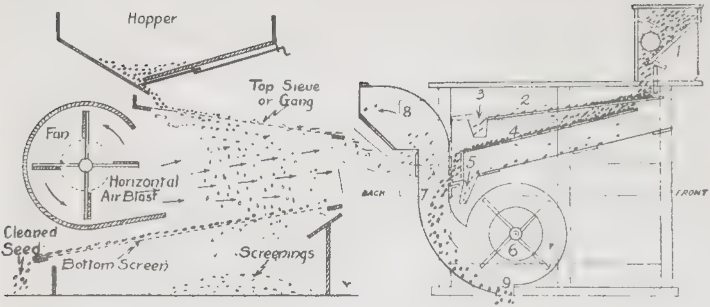
Seed Cleaning

The reasons for cleaning and grading seed may be summarized as follows: 1, removal of weed seeds; 2, elimination of smut balls or bunt; 3, separation of small or light shrunken seeds of low vitality; 4, to obtain seed which is uniform in size and weight, so that it will flow through the seed drill freely, thus enabling the seeds to be spaced more evenly in the ground. When seed is not well spaced in the soil, the missed parts of the drill row provide a better opportunity for weeds to grow and use valuable soil moisture which would otherwise be used by the cultivated crop. Hence, yields of grain may thus be reduced

Principles of Separation

The designs of machines are generally based on some well defined principle; and good understanding of the principle enables an operator to make the machine perform with the highest degree of efficiency. The fundamental principles used for ordinary seed cleaning and grading are quite simple. Separation of seeds are based mainly on the differences in weight, size, shape, length, diameter, and presence or absence of such characteristics as awns and other appendages. However, all of these physical differences of seeds vary from year to year, as a result of the growing conditions which produce the crop. Thus it is difficult to provide definite directions for the cleaning and grading of seed; hence, too, the fact that good judgment and some ingenuity is often required to produce satisfactory results.

The ordinary fanning mill and the Clipper type of machines employ the use of vibrating screens in combination with an air blast. Such machines are



Left: Sectional view of a fanning mill, of which there are many kinds, but all control the horizontal wind draft in essentially the same way. Right: Sectional view of a Clipper fan cleaner: 1, hopper; 2, top screen; 3, scalping spout; 4, bottom screen; 5, screening spout; 6, bottom fan; 7, vertical air column; 8, dust hood; 9, grain discharge.

able to make many kinds of separations, by means of the principles based on the weight, size and shape of seeds and admixtures. These machines are, therefore, quite versatile and will do most of the seed cleaning and grading work found on most farms.

The fanning mill is probably the oldest known type of seed cleaner and has been used by the majority of farmers for many years. Some of the fanning mills vary in design to emphasize some special feature. However, all consist mainly of: 1, A hopper with means to control the flow of seed; 2, one or more top scalping sieves; 3, one bottom screen; 4, a fan to supply a horizontal wind blast between the upper sieves and the bottom screen. Part of the air stream may be directed upward through the top sieves to keep the light straws moving.

The fanning mill is essentially a scalping and cleaning machine. A fairly good job of grading may be done when the most suitable sieves and screens are used and the air blast suitably controlled.

The Clipper type of machine is becoming more popular among seed growers and farmers who are especially anxious to use the best grade of seed possible for their seeding operations. Like the fanning mill, the Clipper uses a top scalping sieve and one lower grading screen. However, the Clipper uses a vertical air blast rather than a horizontal blast. The seed is passed over the lower end of the bottom grading screen and then dropped down a considerable distance through a carefully controlled vertical air stream. The air stream velocity is effected by the combined control of the fan speed by means of step cone pulleys, and the volume of air admitted to the fan through a variable slide opening.

Selecting Sieves and Screens

To determine the correct top sieve and the bottom screen to be used, a good plan is to try them by hand. Place the top sieve on top of the bottom screen, then scatter a sample of seed over the top sieve. Shake the sieve and then examine the seeds, etc., thus separated. When a set of screens has been chosen by the hand method, try them out again in the machine with the air blast. Should it be found that suitable sieves or screens for doing the work satisfactorily are not on hand, a sample of the seed should be sent to a screen manufacturer with the request to supply the correct sieve or screen to make the necessary separation.

The table on page 38 shows sieve and screen sizes for cleaning wheat, oats, barley and rye and may serve as a guide in selecting the best size to use. The weed seeds and other mixtures to be separated must determine the correct

top sieve and bottom screen to use, as learned by trial.

Having selected the correct sieves the next considerations are: 1, The slope of the sieves; 2, amount of shake of the sieves; 3, adjustment of the air blast, 4, hopper feed control.

The slope of the top scalping sieves should be sufficient to allow all the good seed to drop through the top two-thirds of the screen, while large non-required seeds and pieces of straw, pass on, or down, and over the bottom end of the sieve. The lower screen should be adjusted at an angle so that all the good seed passes down the full length of the screen and is discharged over the end, while weed seeds, cracked and small shrunken kernels, fall through the screen. Not all machines are equipped so that the slope of the screens can be varied.

The air blast should be adjusted to separate out light seeds, chaff and dust. It may be necessary to sacrifice a small quantity of the good seed in order to secure the heaviest and plumpest sample obtainable. The air blast may be controlled by means of slide openings at each end of the fan housing, or by regulating the speed of the fan. Good machines use both of these methods, so that excellent wind-blast adjustment can then be obtained. Where wind boards are provided, these should be adjusted so that part of the air is deflected up through the top sieves, to keep the chaff and straw moving freely over the sieve surface.

The feed of the hopper should be regulated so that the seed passes along on the screen thinly. When the screens are overloaded with a heavy layer of grain, many weed seeds and light kernels of grain are worked on top of the seed layer by the heavier seeds and thus do not come into contact with the screen where they can be separated. The capacity of a seed-cleaning machine depends largely on the condition of the seed to be cleaned. Consideration should not be given solely to the number of bushels of grain per hour that is being cleaned: The quality of the cleaned grain should be the most important factor, as well as the main purpose for cleaning and grading the seed.

When seed contains an unusual amount of weed seeds and useless material, it is sometimes advantageous to put the seed through the machine twice. For the first operation the machine can be fitted with suitable screen and used mainly as a scalper for removing most of the undesirable seeds. For the second operation, it may be desirable to use another set of screens to complete the work.

The source of power is also important when considerable quantities of seed are to be cleaned. Hand cranking is unsatisfactory at best. Careful adjustment of slopes of sieves and air blast are of little help when uniformity of speed is not maintained. The ideal power is a throttle-governed engine, or an electric motor if such is available. The finished sample will well repay for the extra trouble taken to arrange suitable power as well as in the labor saved. —H. J. Kemp.

Cleaning of Flax Seed

Special attention is given in this article to flax because it is more difficult to clean than ordinary grain. Often the difficulty is due to the fact that suitable flax sieves or screens have not been included in the collection found on the average farm, and they have been more difficult to obtain as a result of war conditions.

Flax seed cannot be cleaned as fast as the larger seeds such as wheat, oats and barley. This is due largely to flax being more closely similar in size and less to the shape of the weed seeds it often contains. Large commercial firms are able to clean flax seed because they handle large quantities which justify the installation of expensive special equipment. Even these large firms do not depend on one kind of machine.

Cleaning flax seed on the farm with very limited equipment is necessarily slow and perhaps irksome to those who are accustomed to cleaning grain much faster. The average amount of flax seed cleaned on most farms is not considerable, and when one is reconciled and determined to do the job slowly and patiently, and long before seeding time comes around, the job may be more

satisfactorily done with less concern.

When flax seed contains an excessive amount of weed seeds, unthreshed green bolls and pieces of stems, it may be desirable to put the seed through the machine twice. For the first time the machine may be fitted with fairly coarse screens and used as a scalper. The seed can be put through fairly fast for the first operation, to remove most of the trash and a considerable quantity of weed seeds. For the second operation suitable sieves and screens for more precise cleaning and grading are used and the seed is fed to the machine more slowly.

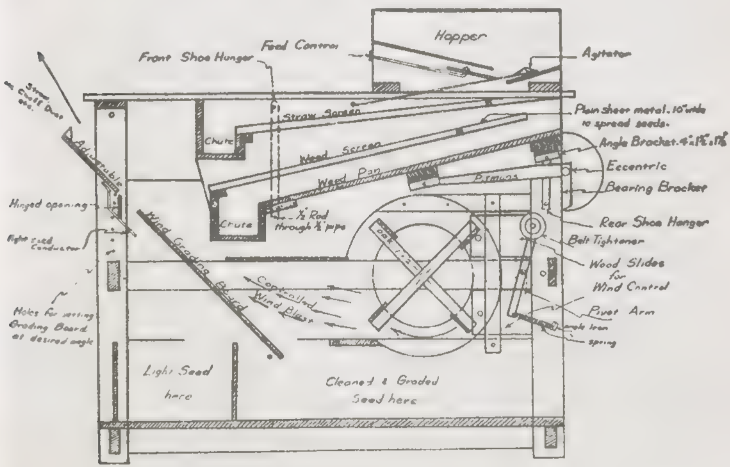
Top scalping sieves may be selected from the following: 2¼x16 wire mesh; 3x16 wire mesh; 3x14 wire mesh; 4/64x¼ slot-hole perforated metal; 4½/64x¼ slot-hole perforated metal; 7/64 round-hole perforated metal.

The bottom screen may be one of the following: 5/64 round-hole perforated metal; 5½/64 round-hole perforated metal; 13x13 wire mesh; 14x14 wire mesh.

In machines where the length of "shake" of the screens can be made longer or shorter, the general rule is that when the flax seed contains much weed seeds and other foreign material the shorter "shake" is used at the highest speed. Longer "shake" at a lower speed can be used for seed which is reasonably clean.

The slope of the sieves and screens and the amount of the air blast should also be carefully adjusted as much as the mechanical means provided will permit.

Uniformity of speed of the "shake" of the screens and the air blast are more important for cleaning flax and other small seeds than for heavier seeds such as wheat, barley, rye, etc. For this reason steady engine power is especially more suitable than cranking by hand.—H. J. Kemp.



SECTIONAL VIEW
showing parts and their location
Fig. 1

Cross-section drawing of the home-made seed-cleaner designed by Mr. Kemp and for which plans are available from the Dominion Experimental Station, Swift Current. —Author's drawing.

Screen Sizes for Seed Cleaning on the Farm

Kind of Grain	TOP			BOTTOM		
	Metal or Wire	Opening	Size	Metal or Wire	Opening	Size
Common Wheat	Metal	Round	12/64, 13/64, 14/64	Metal	Round	7/64, 8/64, 9/64, 10/64
				Metal	Oblong	5/64 x 1/2, 1/14 x 1/2
				Metal	Triangle	8 x 8, 9 x 9
				Wire	Oblong	2 x 12, 2 x 14
				Wire	Square	9 x 9, 10 x 10
Durum Wheat	Metal	Round	14/64, 16/64	Metal	Round	9/64, 10/64
				Wire	Square	7 x 7, 8 x 8
Oats	Metal	Oblong	9/64, 11/64	Metal	Oblong	5/64 x 1/2, 5/64 x 3/4, 1/14 x 3/4
	Wire	Oblong	2x5, 2x6, 3x5/[illegible]	Wire	Oblong	2 x 10, 2 x 11
Barley	Metal	Round	14/64, 16/64, 18/64	Metal	Oblong	
	Metal	Oblong	8/64 x 3/4, 10/64 x 3/4	Wire	Oblong	2 x 9, 2 x 10
				Wire	Square	8 x 8
Flax	Metal	Round	7/64	Metal	Round	5/64, 5½/64, 1/12
	Metal	Oblong	4/64 x 1/2, 1/14 x 1/4	Wire	Square	13 x 13, 14 x 14
	Wire	Oblong	2½ x 16, 3 x 16			
Rye	Metal	Round	9/64, 10/64, 11/64, 12/64	Metal	Round	6/64, 7/64
	Metal	Oblong	8/64 x 3/4	Metal	Triangle	9/64
				Wire	Square	10 x 10, 11 x 11
Sunflowers	Metal	Round	20/64, 22/64, 24/64	Metal	Round	9/64, 10/64
Rape	Metal	Round	6/64, 7/64	Metal	Round	1/16, 1/18, 1/20

How to Identify Wheats

THE Canadian grain grower has a bigger stake in the purity of his wheat than any other farmer in the world. For he sells a premium article in an export market. He needs that premium to offset heavier transportation charges, and he can only assure its continuance by maintaining our traditional standards of quality. It ought to be the main concern of every grain grower in the conduct of his operations. It is more important for him to know how to distinguish Reward from Garnet, Reliance from Preston, Renown from Axminster, than it is to know a Hereford from a Shorthorn.

There is no great wizardry about it. It's an art that can readily be acquired, and unfortunately, there is now sufficient admixture of varieties in the comcial stocks of the country that no one need lack practice. Most any community will provide half a dozen or more varieties for the plant sleuth. Indeed many farmers will obligingly provide that many in one field.

There are sixteen varieties which may grade No. 2 Northern or better. Five of these, Red Fife, Early Red Fife, Ruby, Pioneer, and Renfrew are now grown in such small quantity that they may be dismissed by all save the professionals. Of the remainder Red Bobs and Early Triumph are indistinguishable so that the number of important high quality types is further reduced to ten. To this number should be added Garnet which, though degraded, has a place in western agriculture if its popularity among farmers in certain areas is any measure of value.

Let us then consider the features by which these eleven varieties may be identified.

Farmers make a general classification of wheat into bearded and beardless varieties. It's hardly a fine enough division. The botanist divides the beardless group again into the absolutely bald and the awnleted sorts. The latter have a few short awns or beards at the tip, some less than one-half inch in length. Indeed the only truly bald wheat grown widely in western Canada is Red Bobs and its selections, Supreme and Early Triumph. Because of this unfailing and easily recognized characteristic, these wheats are the easiest of all to identify.

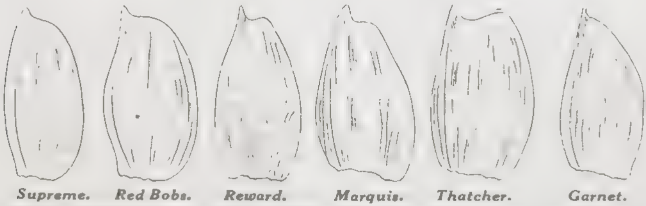
In distinguishing between Supreme and the other two bald sorts look at the chaff. Each head, or spike of wheat is made up of florets placed alternately on the opposite sides of the main stem. Examination of the florets of any variety will show that they vary tremendously on the same head from base to tip. It is wise, therefore, in making comparisons to follow Dr. Newman's advice and use the seventh floret from the bottom in every examination.

On the outsides of each floret is a shell-like piece of chaff which botanists call the glume. Between the two glumes are the kernels, each with its inner and outer chaff coverings, but the glume is the only part of the floret which the botanist looks at in identifying growing grain. Supreme has a glume whose width is less than half its length. Red Bobs and Early Triumph have wider glumes, the width being a little more than half the length. (See fig. 1.)

Standing in the field it is probably impossible to tell Red Bobs from Early Triumph, but samples of the threshed grain will provide a difference. F. Ludlam, the recognized expert at the Chief Grain Inspector's office, Winnipeg, declares that the red color of Red Bobs is unmistakably darker than the more amber red of Early Triumph. It should be noted that Red Bobs 222 is really a re-selection of Early Triumph and should be regarded as that variety.

The threshed grain of Red Bobs shows features that mark it out from other sorts. It is more of a rough hewn berry than Marquis, Garnet or Reward. Some kernels have a distinct hole in the middle of the crease. Others, laid on the crease, have a high keel, like a turkey trussed for carving, with the germ end as the head of the turkey, and sloping off to a flat brush end. These types have also been described as shoe-shaped, with the germ end at the heel, the keel as a

Fig. 1



Typical glumes of some spring wheats. The triangle made by the beak of Marquis is about equal to the triangles suggested by the dotted line. It should be noted that glume characteristics vary from base to tip of the spike.

Thatcher. Apex. Marquis. Renown.
Marquis resembles closely its offspring, the three rust-resistant varieties

high in-step, and the brush end of the grain as the flat toe of the shoe. These are not the typical Red Bobs shape, but most samples contain some of these identifying types, and no other variety grown in western Canada except Renown shows them. (See fig. 2.)

Another variety, Reward, has a characteristic which sets it apart from all others. It is the only variety grown in western Canada which has a fuzzy glume, all the others being smooth and shiny. (See fig. 1.) The only variety it could possibly be mistaken for would be Hayne's Bluestem, grown in Minnesota, but once seen together these two could not be confused, for Reward is fuzzy whereas Hayne's Bluestem is positively hairy.

Reward has another distinct characteristic, not so obvious but which can be discerned with a little study. Looking square at the florets, their centre lines are not in line with the main stalk but point outward like the toes of the sergeant-major's footprints on parade. (See fig. 5.)

Marquis wheat is the cornerstone of Canada's spring wheat industry. Its release overshadows in importance every other chapter in our wheat-growing history. Until rust became a regular menace Marquis was the most widely acceptable variety this country had ever known. Mr. Ludlam declares that the grain inspection department still regards it as their standard. Everything about the kernel is just about right. The miller knows that flour made from kernels of its characteristic color will be about right in color. In none of its kernel features, length, size, shape, germ, or brush is it extreme. So far as kernel characteristics go, Marquis is regarded as the normal and other varieties measured by their departures from it.

The quality of Marquis has been so firmly established that the plant breeders have used it widely in creating new varieties with the result that many of our newer sorts contain so much Marquis blood that it is hard to distinguish them from that parent. Thatcher, Reward, and Apex, the three recognized rust-proof wheats all have 50 per cent Marquis wheat in their ancestry and consequently resemble it much in appearance. They are all awnleted, with smooth, white glumes, but there are some striking features about the heads of these four varieties which make them all distinctive at arm's length.

There are three respects in which these four varieties show a difference, compactness, awn length, and taper toward the point, or lack of it. If you arrange these four sorts according to compactness you will find Thatcher has the shortest, densest head, with the stalk rarely visible between the florets. Renown is at the other end of the scale. Apex and Marquis are intermediate in laxness.

In awn length they run in the same order. Edgar Brett, of the Dominion Seed Branch, Winnipeg, declares that Thatcher is sometimes so heavily awnleted as to appear almost awned, the awnlets appearing two-thirds of the way down the head. Renown is almost bald, its short awnlets curving in like Marquis Sask. 7 of unhappy memory. Here again Apex and Marquis are intermediate.

Apex and Marquis frequently show a decided tapering from the middle of the head up. (See fig. 5.) Renown carries its width squarely to the end very noticeably. Apex has the weakest straw of the four. The straw of Thatcher, though strong, is noticeably finer than Renown.

Thatcher has one peculiarity that marks it safely A crop will show quite a proportion of crinkled heads and necks, as though the spike had a great deal of difficulty coming through the shot blade. The deformed heads keep this peculiarity right through their whole lives. This feature of Thatcher is so noticeable that when the variety was first released it was proposed to call it Crinklehead.

The kernel color of Thatcher is perhaps its outstanding peculiarity. In the grain inspector's office it is described as greyish. Once seen it is unmistable. Nearly one third of the kernel surface farthest away from the germ looks to the naked eye as though it had microscopic scales like the wings of a butterfly. The effect of this is to make a sample look bleached.

Renown has a distinctive feature which, unfortunately, can be detected only in the ripe straw. It shows a distinctive purple shade. The glumes of Renown vary as one proceeds up the head. At the base they have almost no shoulder as in Garnet. In the centre the shoulders are square like Marquis. At the tip they are elevated, but not to the same extent as Thatcher.

Because of the beautiful berry of Renown this variety threatens to rival Reward as a show grain. On the other hand it has not yielded as well as Thatcher. The rust laboratory at Winnipeg have for some years been making selections of Renown which will stand up in yield, and it is most likely that within a short time one of these selections will displace the first type sent out.

It should be stated that three of these varieties are quite new; their type is not so definitely fixed as Marquis and nondescripts often appear in a pure crop. Even Marquis itself, as those who have read Dr. Newman's monograph on that variety know, contains a wide range of forms. While I have noted the tendency of that variety to run to a point at the tip, in some years Marquis will exhibit the opposite tendency thickening at the

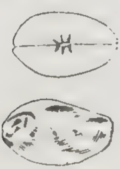


Fig. 2

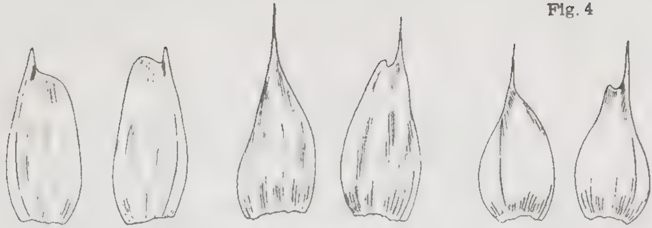
Off-types.

Frequently found in Red Bobs

Fig. 3 *Some kernel characteristics.*

Top row, left to right: Garnet, showing the acute angle of the germ and the sled shaped kernel; Marquis intermediate in both respects; Renown showing an abrupt germ end. prominent tip of germ. Bottom row: Garnet showing large germ with square shoulders; Marquis an intermediate type; Ceres with long kernel and long narrow germ.

Fig. 4



Glumes of the bearded high quality spring wheats showing range in each case from base to apex.

tip almost like Kitchener. In all these varieties there is some overlapping and the distinctions noted above are not as clear cut as might be wished.

More controversy has centered around Garnet than any other variety ever distributed in western Canada. Millers discriminate against it so that its detection is doubly important. Fortunately it has a number of unfailing characteristics which make identification easy. Even in a very immature state a crop of Garnet is much lighter in color than say Marquis; a yellow-green for Garnet as against blue-green for Marquis.

The shoulders of the glumes of Garnet are altogether wanting or so narrow as to appear shoulderless (See fig. 1.) These narrow pointed glumes give the florets the appearance of many pointed crowns. The whole spike seems to be made up of many jagged points, quite unlike the other varieties under consideration.

When it was first proposed to pass regulations limiting the percentage of Garnet in the top grades of wheat, cerealists said it wasn't practical—no visual examination of grain could estimate accurately enough the adulteration of the better varieties of Garnet. With such a similarity in the sample of our hard, red, spring varieties it is a difficult job to identify varieties, let alone to estimate percentages of mixtures. Size, shape of kernel, depth of crease, shape of cheeks are all very misleading because of the differences from season to season and differences due to location. Reward is our plumpest berry, with the shallowest crease and fullest cheek, yet a sample of Marquis grown in a good season will surpass a sample of Reward grown in a less favorable year. Renown, grown in Manitoba last year was uniformly better than the Reward coming through the inspectors' hands except samples from the Peace River. The writer has drawings of typical cross sections of the varieties mentioned in this article but refuses to publish them because he considers them worthless as a guide.

Nevertheless there are some kernel features which are so reliable that inspectors are now guessing mixtures with Garnet in them down to within one per cent. The most distinctive of these features is the acute angle of the germ. (See fig. 3.) Parker's Marquis, according to Mr. Ludlam, has a much more abrupt germ. Renown even more so. The second is what the inspectors call the sled shape of the Garnet kernel. Laid on its back with the crease uppermost the top surface is nearly straight, with the bottom decidedly curved. Lastly, the germ of Garnet presents fairly constant features in being large with sharp corners especially near the point.

Bearded wheats of high quality are comparatively new in western Canada. In the middle twenties, when rust was causing frequent losses and the present rust-resistant varieties were in their infancy, the Brandon Experimental Farm distributed Ceres to tide over the emer-

Fig. 5

gency. Ceres has some rust resistance but not enough to cope with epidemics like that of 1935. In that year it suffered nearly as bad as varieties regarded as having no resistance whatever. That epidemic marked the beginning of the end for Ceres. We now have the fully rust-resistant varieties to draw from and there seems to be no reason for continuing its use. However, because of its yield under favorable condition and its quality, a few still grow it.

Reliance and Canus are two bearded varieties of high quality obtained by crossing Kanred, a hard winter wheat, with Marquis. They have been recommended for portions of Alberta and Saskatchewan because they have stood up so well under drought conditions.

Ceres may be distinguished from the two dry land wheats by the fact the heads do not all stand erect but show a disposition to lean over, the glumes are narrower and longer, and the beak or tip of the glume is not so long (see fig. 4). It produces the longest berry grown in Manitoba.

Reliance has a feature that is valuable in distinguishing it. A cross section of the head is nearly square. It is a later variety than Canus, weaker in the straw and with a head less dense. Reliance follows its winter wheat parent, having a kernel which is long and narrow, lighter in color and less bright. All the winter wheats have a longer brush at the end of the kernel, and this is equally true of Reliance. All three of these bearded wheats have a long, narrow germ.

This list by no means includes all the wheats which are grown in western Canada, although it names about all that ought to be grown if the question

of quality is to remain uppermost. Dr. R. F. Peterson, of the Rust Research Laboratory, and Prof. H. C. Laidlaw, Manitoba University, have made the most recent classification of prairie grown wheats which includes 37 variety names. Unfortunately their key is not available for public distribution. Those who are anxious to pursue the subject farther, however, will get a great deal of help from Dr. Newman's Handbook of Canadian spring wheat varieties, which is Farmers' Bulletin No. 18, and available from the Central Experimental Farm, Ottawa, gratis. The recognized authority on the subject is technical bulletin No 459 obtainable from the superintendent of documents, department of agriculture, Washington, D.C., for 25 cents (American coins). It is dated April, 1935, and is not so up-to-date as Dr. Newman's bulletin of September, 1936.

Weed Control

Weed Enemies are Vulnerable

FARM-grown weeds are directly responsible for more financial failure on prairie farms than any other single cause. The cost of plowing, harrowing, sowing and harvesting an acre of land is quite small, compared with the cost of the extra cultivation required in the continuous fight against invasion by thistles, wild oats, quack grass and the numerous army of weeds that yearly add to the farmer's toilsome task.

On the one hand, weeds are enemies and on the other, man's existence on the prairies would be short-lived, were it not for mother nature's wise provision of these hardy, venturesome plants that reclothe the soil stripped bare by man in his efforts to extract the last possible bushel of grain that can be grown. Weeds are mother nature's watch dog. The presence of weeds in numbers is an indication that there is something wrong with the farm methods. Weeds are only the advance guard that drift in and are followed by such evils as soil drifting, soil poverty and farm failures. They are the fifth columnists that multiply and take possession. As the weeds increase, more cultivation is necessary, with the result that the rate of destruction of soil fibre and soil structure, is accelerated. Instead of a summerfallow requiring one plowing and one or two cultivations in a season, five, ten, or twenty cultivations are given in the preparation of the fallow.

A frontal attack is not always the sanest. In war, the weaknesses of the enemy are studied and the attack is made on the weakest front. So in the war with weeds. Their weaknesses—and most weeds have weaknesses—have to be studied, and the attack planned accordingly.

In the investigation work on the experimental farm at Brandon, and on the reclamation station and sub-stations, certain vulnerable periods have been found in the life history of some of the more troublesome weeds. Russian thistle plants, that annually cover millions of acres of farm land, can be destroyed by discing, cultivating, or plowing, at the time the grain is cut. Left until late fall, or early spring, millions of weed seeds are produced and pollute the soil for the succeeding crop. Harvest tillage of stubble land also destroys volunteer clover plants that, the next year, may produce melilot taint in the wheat crop. Late season and spring cultivations have so far failed to do more than destroy some plants of clover, and transplant others.

Canada thistle has occasionally been destroyed by mowing at the right time, but much more frequently this plan has failed. On the heavy valley land at the experimental farm, Canada thistle seeds drift in on the wind; and this is one of the problem weeds on this soil. Following up a "tip" from the Dominion weed farm, at Regina, the cost of summerfallowing for thistles has been reduced. The labor connected with their destruction has been spread over a longer period and thistle control has been secured.

The plan consists of fall plowing, with a shallow spring cultivation to level the land. From the spring until July 10, livestock pasture on the edible weeds. Then the fields are given another plowing; and between then and freeze-up, two double cultivations are given. The thistles are allowed to become from six to eight inches high and the roots of the thistles are cut about five inches below the soil surface. The important point in the cultivations is to leave the green thistle tops with about five inches of white roots on top of the soil. This system has proven quite effective.

Even wild oats have certain weaknesses. The weather and soil condition during the spring, favor the germination of these pests. Farmers take advantage of this and put the field intended for oats and barley into seed-bed condition, either in the fall or early spring. As soon as the wild oats become a green mass, they are turned under and the coarse grains are sown. Unfortunately, the wild oat crop takes up much plant food and soil moisture; and, as a result, the succeeding crop is often short and the grain poorly filled. This is again reflected in the lack of quantity and quality of the feeds for pigs, poultry, cattle and horses.

On the Brandon farm, the introduction of two years of grass and legume hay crop into a straight grain-growing rotation, has brought about the complete control of wild oats, whereas on the adjoining area, on which the grain-growing rotations have been continued, the dockage for wild oats ran from four to nine per cent in 1940.

Perennial bindweed is troublesome in some districts. Comparatively little work has been done in western Canada in investigating the best methods of control. However, reports on certain experiments conducted in the United States, show that instead of keeping the land black all the time, this weed is more quickly and more cheaply destroyed by allowing the bindweed to grow for eight days after it emerges from the soil. Up to eight days, the bindweed continues to draw on the plant food stored in its roots, but after a little more than a week above ground, the reverse process of storing in the roots commences. This plan is well worthy of trial where this weed is troublesome.

Even couch grass has one weak habit. Given occasional plowings or cultivations, it thrives in many districts. The root stocks penetrate to the full depth of the plowing or cultivation. Left undisturbed, the running rootstocks that produce the new plants so freely, gradually establish themselves in the top three inches of soil. On the Dominion reclamation station, Melita, couch grass has been eradicated in each of the last three seasons by the following system: Commencing in mid-June, the top growth of grass is removed and made into hay; and three shallow cultivations are given. Shortly before harvest, the fields are one-way disced and between then and freeze-up, three more cultivations have resulted in the complete destruction of solid stands of grass. The total cost, including all overhead expenses, has been four dollars per acre.

Sufficient has been given to show that as there are other ways of killing a cat than choking it with butter, so there are other ways of controlling weeds, besides keeping the land black for one or two seasons.

For such dangerous weeds as leafy spurge, first invasions can be met with weed-destroying chemicals; and, here again, the weakness of the weeds must be found. Several years' investigation by the Dominion experimental farm, Brandon, has proven that chemicals applied late in the fall, shortly before the spurge goes into winter dormancy, will prove much more damaging than three or four applications during the growing season. A follow-up treatment the next year is imperative, but knowledge of the time to give the first treatment has greatly reduced the cost of the destruction of this weed.—M. J. Tinline.

Corn and Weeds

The average western farmer loses more from weeds than from any other source. Farmers in the corn belt, or where other inter-tilled crops can be grown, have not the same trouble because such crops give plenty of

opportunity to deal with weed pests.

Many farmers have been quite successful with a few acres of potatoes or other root crops, but ten acres is about the limit. Such crops have to be harvested generally at the same time as grain when labor is scarce and high priced. Corn, on the other hand, is the only inter-tilled crop that we can raise and handle with the minimum of hand labor, and on a scale large enough to help us in solving our weed problem.

If you can time your corn planting so that the weeds can be destroyed before the corn comes through the ground it will give you the best possible start with the crop. Where a corn planter has been used you can cultivate before the corn comes up. This will ridge the ground so that a later cross harrowing will give as near 100 per cent kill as possible.

The harrow does a very efficient job alone. Cross harrowing does less damage to the crop than harrowing along the rows. Small corn is damaged considerably by the harrow, but after it gets four inches high, it will stand a lot of punishment with a light harrow. Cultivation with this implement may be continued till the corn is so high that it will not straighten up after the harrow has passed. It may look bad immediately after you have gone over the field but the next day it will recover surprisingly.

Care must be taken not to let the weeds get far enough along for the roots to get tough as the best cultivator will not get them then. Plenty of harrowing till the corn gets too high is very beneficial. Corn is a strong plant and stands it much better than the weeds.

All spring-tooth harrows are not of the same design, but the one I used last summer was very satisfactory, and I expect to use it again. I believe it is better than the cultivator for going cross ways after that implement. The operator handles it by holding to the lever. Part of the time I had a rope tied to it in such a way as to make it easy to lift. Handles could be attached to it similar to a walking cultivator.

Some people use the duck-foot cultivator, adjusted so as not to injure the corn. One of our Russian immigrants has a cultivator very much like a wheelbarrow with a bar of iron attached to the legs. It works very much like a rod weeder.

As the season advances care should be taken not to injure the roots by too close cultivation. Many good corn belt farmers try to cultivate after each rain, regardless of the weed growth. Thorough cultivation pays with both corn and potatoes, both for the crop on the ground, and for the one which follows the next year.

For the man who is interested in growing some feed, I suggest sowing corn on a piece of his summerfallow land, keeping a record of his costs and results, both in feed grown, and the crop of small grain in the succeeding year. For many it will be surprising.

Sow Thistle

Due to drier seasons which make timely cultivation easier and also more effective, this weed isn't nearly so great a problem as it was a few years ago. Being more familiar with it, we attack it with much more confidence than formerly.

It is a great mistake to think as some do that sow thistle is a menace that has shot its bolt, as it were, and that it will never be the same problem again. A few rainy seasons will blow that idea sky high.

Where sow thistle is prevalent and going to seed on waste land the seeds are being blown for miles. To eradicate the pest where it is so well established is a practical impossibility. Under these conditions, the best we can do is to control it each on his own farm. This can be done successfully by periodically fallowing. Well fallowed land remains free of them for only a short time. It is soon reseeded from outside sources and in the course of from two to several years has again to be fallowed.

Such practices as cutting the crop and plowing the land in one operation are particularly effective in drier years in controlling the weed to a point where the frequency of fallowing is greatly reduced. Plowing down just before the plant comes into bloom, seems to be the hardest single blow we can give it.

It is very expensive to handle in conjunction with other weeds such as wild oats, mustard and stink weed, because to control these annuals work on fallow must be begun early. The only hope then is to prevent the thistles from making any green growth all summer which is not only expensive but also conducive to soil drifting.

Wild Oats

No single weed causes more loss to agriculture on the plains than wild oats. Their presence in the soil reduces yields and in the threshed grain they lower grades.

The first line of defense against them is to sow clean seed. Being difficult to separate from other grains, special cleaning equipment and plenty of time is required to clean the last wild oat out of seed grain. The ordinary fanning mill isn't equal to the task. It isn't good management to expend a lot of effort to clean wild oats out of a field and then proceed to use seed that is not absolutely free of them.

To combat this plant successfully it is necessary to observe a few of the plant's habits of growth. It is an annual; the seed normally germinates in the spring and the plant ripens in the summer. We must encourage the seeds to germinate and then kill the plants before they mature. Wild oats mature before crops in which they grow are ready to cut. The seeds shatter from the heads very easily and much of the seed is usually on the ground before the crop is cut. More seed shatters in the processes of stooking and threshing.

Encouraging these shattered seeds to grow early the following spring, so that the young plants may be killed before it is too late to sow a crop of barley or oats for green feed, is the most deadly defense against their establishment in the field. Shallow cultivation in the fall which covers the seed but does not bury it too deeply is by all means the best method of getting wild oats to germinate early and liberally in the spring. A scratch with the harrow very early in the spring also helps.

It is characteristic of wild oats that very few of the seeds will germinate the same season they have ripened. Since there is little germination in the fall the frost of winter has little effect.

The seeds are very viable; if buried deeply they will remain in the ground for years and still grow when conditions suit. That is another good reason for keeping them near the surface by shallow cultivation in the fall.

In a campaign against wild oats one has to forget about growing wheat or any other crop which must be sown early. To grow wheat and kill wild oats at the same time is a practical impossibility. The principle of fall cultivation is of course equally effective on land that is to be summerfallowed.

The mold-board plow or the one-way may be used to kill the growth in the spring. The latter, using a seeder attachment to sow the crop, seems to be particularly effective.—H.A.

Quack Grass

Much has been writen about quack grass eradication, with many writers favoring the method of pulling the roots out to the surface. Of course it's quite effective, but when I tried it, I found this costly in time and power. I bought a quarter five years ago that had 85 acres of quack, 25 of which was a solid mat. The soil is a heavy loam. In 1936 I summerfallowed 60 acres, the main implement used being a cultivator with narrow points. Cultivation continued till late in October. I'll never again use this method. I didn't think of the amount of work it would entail to rake and burn the roots brought to the surface. There were tons of it! Of course I got a satisfactory kill, though a few quack plants survived the following year in the low spots.

In 1938, I decided to use the shallow tillage method of eradication on the 25 acres that were solid with quack. The plowing was done with a breaker to a depth of seven to eight inches about the middle of June. A disc was used to close the furrows, and level the land out. Following that, a one-way disc was used three times, and a duckfoot cultivator for the remainder of the season. No green growth was allowed to appear for long. This necessitated cultivations about every ten days. Wet periods required more frequent cultivations. The

shovels of the cultivator were kept sharp. On stony land, the one-way disc would work more satisfactorily perhaps. Cultivation was kept up periodically to the end of October. This method took so much less power and labor, that I was somewhat skeptical as to the results. However, my skepticism vanished the following year. Quack grass eradication no longer holds any terror for me. I wish wild oats were as easy to kill.—Jos. Pasreno.

Wild Millet

This weed can be easily controlled provided certain precautions are taken, since the seeds, unlike stinkweed, remain viable for only a few years. This weed requires a short season in which to grow and produce seed and as a result many summerfallows are reseeded by plants that are missed by the cultivator or ripen seed during the rush of the harvest. Cleaner fallow fields are necessary in the control of wild millet.

Shallow spring cultivation of fallowed land loosens the top soil, weed seeds near the surface are air dried and remain dormant until the soil is again packed firmly around them. Weed seeds below the dry soil frequently fail in their efforts to push their young shoots to the surface. Harrowing the seed bed just before the crop emerges is another precaution that can be taken and in some years it may even be necessary to harrow the grain after emergence in order to thin out the stand of this troublesome weed. Experience at Brandon has proved that a four-year rotation of summerfallow, grain, sweet clover, grain, is quite effective in bringing about complete eradication. Many farmers will find well planned crop rotations to be more effective in weed control than costly cultivation.

Leafy Spurge

Leafy spurge is a troublesome weed in Manitoba where it has been found in at least fifty municipalities during the last ten years. It propagates both by the seed and by the rootstocks; and it is these woody, perennial rootstocks that are responsible for the difficulty of eradicating it. The roots that go down deep into the soil are thick, woody and reddish-brown in color; and the horizontal roots carry many buds that will result in the development of many new plants at various distances from the parent plant.

Of particular importance is the fact that the roots of leafy spurge will live for many months in the soil, even if they are prevented from making any top growth; and it is for this reason that control of this weed by cultural methods requires at least two full seasons. Because of this difficulty, control measures sometimes require a combination of cultural methods and syraying or dusting, depending on whether there are just a few patches in the field, or whether whole fields have more or less of it, with some patches especially bad.

Much work in the control of leafy spurge has been done by the Dominion experimental farm, Brandon; and a bulletin embodying the results of experimental work has recently been issued. A paragraph in this bulletin condenses control measures as follows:

"The most feasible plan would be to sow a crop as usual, taking every precaution, however, to avoid dragging the roots. The patches, both large and small, should be well marked by stakes. The cultivation of the large clumps should commence in May and be repeated sufficiently often to prevent any new growth showing above ground. The small clumps should receive the first spraying in June, a second in September and a third the following spring. Cultivation of the larger patches should be continued throughout the second year and there should be frequent inspections of the crops and any new growth of this persistent weed starting up should be given chemical treatment."

The spray recommended is Altacide, a product containing sodium chlorate, applied at the rate of 2½ pounds per 100 square feet in the form of a dust, or mixed with water as a spray in the proportion of one pound to a gallon of water. One gallon of liquid is spread over 100 square feet. Less Altacide is required for a complete kill of the weed if one pound of the 2½ pounds is applied in June, another pound in September and the balance, ½-pound, the following spring, as outlined above.

Mustard

Summer never seems to be very far advanced before it is possible to see fields here and there that seem to have been deliberately seeded to mustard, so thick does it stand and so thoroughly are the fields covered with the yellow blossoms. It has been calculated experimentally that a heavy infestation in a field of oats, means a loss of about one-seventh of the crop. This is bad and if you find it hard to realize how bad it is, calculate your income for a year and then write out a cheque for the one-seventh of the amount and give it away to the first person you meet. You won't do it, of course, but it won't do any harm to imagine how pleased you would be if you did.

Now that mustard has become so very common, more or less heroic measures are required to get rid of it. Many different methods have been tried, but the most satisfactory is to spray the crop with a three per cent solution of copper sulphate, applied at the rate of about 70 gallons per acre. This kills practically 100 per cent of the mustard in the crop, but does not kill the grain. Dusting with calcium cyanamide dust at the rate of 100 pounds per acre gives equally good results. Cyanamide is a nitrogenous fertilizer and the Dominion experimental farms system advises that "the increased yield of grain resulting from its application often pays the cost of the treatment." Other methods of treatment may be tried such as harrowing the fields when the grain is young, or increasing the rate of seeding, but they are not nearly as effective as spraying or dusting.

Stinkweed

Stinkweed is about as desirable as its name indicates, and like most other really bad weeds, it is most troublesome on good soil where moisture is comparatively abundant. It is very troublesome in the area served by the Melfort Experiment Station, with the result that experiments have been conducted each year since the station was started, with a view to developing methods for its control.

Results so far have been very encouraging and they indicate that a combination of cultural practices can pretty well take care of the stinkweed problem in grain crops. The tests made involved seeding at different rates, the application of ammonium phosphate fertilizer and harrowing after seeding. The efficiency of the control method was checked by counting the number of weeds to be found in each case on an area a yard wide and three yards long. It was found, for example, that where seeding was at the rate of only one bushel of wheat, with no fertilizer applied and no harrowing, there were 342 weeds per 27 square feet on summerfallow and 197 on stubble. Weed count decreased as the rate of seeding increased until at the 2½ bushel rate there were only 201 on fallow and 141 on stubble. Adding 40 pounds per acre of ammonium phosphate reduced the weed count from 201 where the seeding was 2½ bushels per acre, to 36.

Harrowing also proved beneficial. Where the rate of seeding was two bushels per acre, harrowing when the weeds germinated reduced the weed count from 281 to 170, while harrowing the second time, when the weeds were in the two-leaf stage, further reduced the count to 130. If one stroke of the harrows only is given, Mr. Burns, who is in charge of the field crop work at the station, suggests that it should be done when the weeds are in the two-leaf stage. In no case did harrowing reduce the yield of the crop. On the contrary it semed to have a beneficial effect, but it is suggested that where harrowing is to be practised, the rate of seeding should not be less than two bushels per acre.

As a result of the tests made at Melfort, it is believed that heavy seeding, supplemented by fertilizer and a light harrowing of the crop, will take care of most of the stinkweed problem in the grain fields of that area.

Canada Thistle

One of the characteristics of Canada thistle is that it does not make its appearance as early in the spring as some other weeds. This, in turn, means that its growth can generally be checked

during the summer in fields that can be seeded early and thickly to a crop like barley, which will occupy the soil before the Canada thistle begins to show very much.

It reproduces itself from seed and also from fragments of its perennial roots which get broken off by farm implements during cultivation. A small piece of Canada thistle root from one to three inches in length may, within three years time, produce a solid patch as large as 60 feet in diameter, owing to the fact that the underground roots of this weed bear numerous buds and are able to store up large quantities of reserve food material. Consequently, once established, the Canada thistle is likely to remain indefinitely in the soil, renewing itself from year to year, unless some adequate steps are taken to eradicate every piece of living root.

Experiments conducted from the University of Saskatchewan in several parts of the province have led to a method of control, which it is claimed will completely eradicate Canada thistle in one season by the use of shallow cultivation. It is pointed out, however, that to be fully effective, the control operation should start not earlier than July 20 and not later than August 5. The reason for beginning at this particular time of the year is that the plants are in full bloom and the perennial roots are as nearly exhausted of reserve food as they are likely to be at any other time of the year.

The control measure advised is as follows: First, the thistles are encouraged to grow during the early part of the season by sowing the infested field to a feed crop of oats or barley, at two-thirds the usual rate of seeding. This seeding also makes it unnecessary to cultivate the field until late July, or between the dates already mentioned. The crop, together with the thistle, should be cut and removed and the land plowed at once, with sharp shares, to a depth of approximately four inches, after which it should be disced or harrowed, in order to close the furrows. Following this plowing, the surface should be kept thoroughly free of Canada thistle shoots until freezing weather, by using a sharp disc as required (preferably the one-way), a duck-foot cultivator, a wire-weeder, or the rod-weeder. It is claimed by the university authorities that if these recommendations are carefully and consistently followed, 95 per cent of the roots will die before freeze-up, regardless of how deep they have penetrated; and the remaining live roots will be so exhausted that they will be killed during the winter.

Pests and Diseases of Field Crops

Grasshoppers

ALL grains and clovers are attacked by one or more species of grasshoppers. There are three principal species, the clear-winged grasshopper, the lesser migratory grasshopper and the two-striped grasshopper. There is, fortunately, only one generation per year, but from the last of May until harvest time, the young plants along the edges of fields will be destroyed, leaves eaten from the plants throughout the field and, later in the season, the heads of plants are cut off.

Grasshoppers are injurious at two stages in their life history; first when they are in the nymph, or wingless stage; and later on, when the winged adults appear. Nymphs of the clear-winged grasshopper appear in the areas of short grass along lanes, roadsides and edges of fields, while those of the other two species are found throughout fields and on dry ridges.

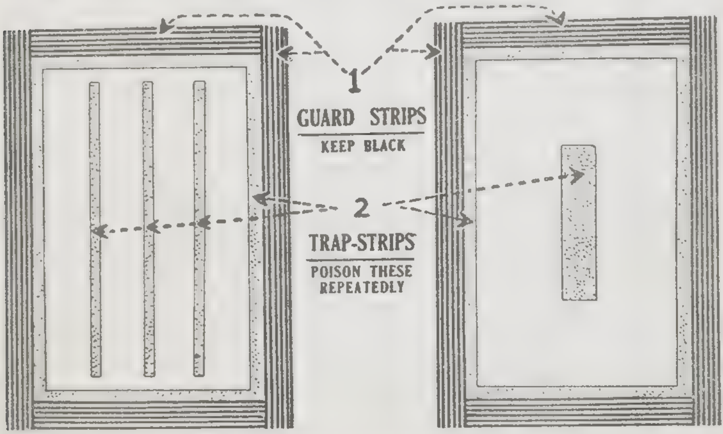
Grasshopper control often becomes a serious problem, especially in Saskatchewan. A letter from S. H. Vigor, field crops commissioner for Saskatchewan points out that coarse grains and flax are more susceptible to damage from grasshoppers than is the wheat crop.

A special leaflet has been issued by the Saskatchewan department of agriculture on the subject of "Grasshopper Con-

trol by Proper Summerfallowing" and Mr. Vigor's letter points out that, "while the department of agriculture is making poison bait supplies available to farmers through municipal councils, it is extremely important that early attention be given to fields of stubble which will be summerfallowed this year. It is on stubble fields that the 'hoppers we will have, will hatch; and while crops on summerfallow will be free from 'hoppers, there is always a movement of young 'hoppers from uncropped stubble to nearby crops, unless this movement is prevented."

The leaflet points out that in all parts of the area where an outbreak of 'hoppers occurs, whether light or heavy, two things are essential for satisfactory control under Saskatchewan conditions. These are: (1) The summerfallowing of all unseeded stubble in such a way as to concentrate the 'hoppers for poisoning, before they move to nearby crops; (2) the most efficient use of poison bait. The essential features of the control plan itself are three in number. The first of these is the use of guard strips at least four rods wide (and preferably plowed) all around the field, before the 'hoppers hatch. These guard strips should be kept black until the 'hoppers hatch. The purpose is to delay the 'hopper movement from the summerfallow, so that other necessary steps can be taken. The second essential is the proper use of trap strips not less than two rods wide, the most important trap being just inside the guard, where volunteer growth or early-sown grain is provided for the 'hoppers to congregate in as the remainder of the field is being worked up. If such trap strips were not provided. the 'hoppers would be forced to other fields in search of food, before they could be poisoned. Another trap strip should be provided in the centre of the field and, where the field is quite large, other trap strips are advisable every thirty rods. The idea is that there should be sufficient trap strips so that the 'hoppers will not be too crowded and move away in search of food. When the 'hoppers have been poisoned, the trap strips can be worked up like the remainder of the field.

The spreading of the poison bait should begin as soon as the 'hoppers are sufficiently numerous in the strips; and the poisoning should be repeated whenever necessary. By the use of this method it is only necessary to poison



This sketch represents the plan of summerfallow control of grasshoppers in Saskatchewan, where serious infestations are to be expected.

about ten per cent of the entire area of the field and the concentration of the 'hoppers in a comparatively small area makes it more likely that they will eat the bait readily. There is also more likelihood that they will be destroyed before they have spread over the entire district.

Where poison is not supplied by government agency and it is necessary for the individual to mix it himself, a good bait can be made at home by taking 50 pounds of bran, an equal bulk of sawdust (preferably poplar), a quart of liquid sodium arsenite (containing two pounds of white arsenic), and from 10 to 12 gallons of water. If the sodium arsenite is not available, four pounds of paris green or white arsenic may be used. To prepare the bait, mix the bran and sawdust dry. Add the poison to the water, and then mix water and poison with the dry bran and sawdust. About 20 pounds of mixed bait to the acre will be sufficient; and the maximum kill will require about 48 hours after the bait has been applied. This is the grasshopper bait recommended by Dean A. V. Mitchener of the University of Manitoba.

Sawfly

"Any type of farming practice, or rotation, in which wheat is seeded on land containing infested stubble, or adjoining such land, tends to increase the abundance of the sawfly. Infestations in large field units, which are summerfallowed in alternate years, are usually found to be confined to the margins. Strip farming, on the other hand, with many margins exposed to invasion from adjacent summerfallow, greatly intensifies the infestation.

"The increase in the use of the combined harvester-thresher has tended to increase losses from this insect. As the insect cuts the stems just before the wheat is ready to be harvested, the practice of letting the crop stand until it is thoroughly ripe, so that it can be combined, ensures all of the infested stems being cut by the insect."

Control measures recommended are of three kinds. First, since the adult fly seldom travels farther after emergence than is sufficient to find suitable plants on which it can lay its eggs, infestations are normally heaviest along the margins of fields. Trap crops have, therefore, been recommended, of which the best is probably wheat, sown about two weeks earlier on summerfallow than the main crop. This trap crop must then be cut for hay, so as to destroy the eggs and the grubs in the stems. The second method is to plow the land deeply (about six inches) any time between the harvesting season and the first of June the following year. This method is designed to destroy the grubs low down in the stems and bury them so deeply that they cannot emerge the following season. The third method is to use surface cultivation in the fall or early spring so as to throw the stubble out on the surface of the ground where the grubs will be destroyed through exposure.

Both of the latter methods are more or less impracticable over comparatively large areas in western Canada that are subject to soil drifting. During recent years the trash cover has become a standard soil conservation practice; and it is important for the success of such a soil cover that the stubble or trash must remain anchored in the soil. Consequently, if cultivation designed to throw the stubble on the surface, is given, the anchorage for the trash is lost; if an attempt is made to bury the grubs so that they cannot emerge, the trash cover itself is lost. In other words, changes in farming practice referred to above, have made it more or less impracticable to successfully and generally control sawfly infestations with maximum efficiency; and this is one of the outstanding reasons why the plant breeder has been called on to produce varieties of wheat which will be immune to sawfly, if it is possible to do so.

Sawfly on Flax

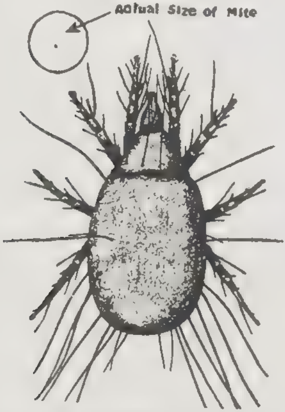
EARLY seeded flax is likely to be attacked by the wheat stem sawfly. Late seeded flax is practically certain to be free of attack. However, damage even to the early crop is not likely to be serious. Any casual attacks can be detected in the same way as for wheat,

since the stems of the infested plants will be filled by a fine, sawdustlike material and the stems of any plants that are attacked will be weakened.

The flax plant is not a normal host for the wheat stem sawfly. Most of the insects will die in the early stages and it can be expected that very little damage will be done.

Grain Mites

Mites as found in grain are of five kinds, of which only one, the common mite, can do any physical damage to the grain. This mite may damage as much as ten per cent of the germ end of the wheat berry. When present in large numbers, moisture is added to the stored grain by the respiration of the mites and the average per cent of moisture in mite-infested grain is a little over 17 per cent. They are not generally found in grain where the moisture is much below 13 per cent.



A grain mite magnified from its actual size shown approximately by the dot in the circle. Reproduction from a circular issued by the Alberta department of agriculture.

"The grain mite is an extremely small insect-like organism. It is practically white in color and difficult to detect with the naked eye. Anyone with an appreciable amount of wheat on hand should inspect it for this pest. They are more likely to appear in old wheat, or in wheat with more than a normal moisture content. In such grain they may increase in numbers very rapidly and the grain will deteriorate proportionately. With the presence of mites, both the moisture content and the temperature of the grain is increased. Wheat found to be heating or to have become tough in the bin should be regarded with suspicion.

"The temperature of wheat in small bins with proper ventilation should naturally be somewhat the same as that of the air outside the bin. If a thermometer is placed on a stick and pushed down in the centre of the bin, the temperature of the grain can readily be obtained at various levels. If it is found that the temperature of the wheat is abnormally high, small samples should be taken, screened, and the screenings carefully examined on a black surface, preferably with a magnifying glass. This should be done frequently, and if mites are found, their presence should be reported to a local elevator agent at once, or to the department of agriculture. Constant vigilance may save a farmer considerable loss. Granaries, especially new ones, should be well ventilated. This will tend to arrest heating by allowing excess moisture to pass off and so arrest the development of the pest.

"Briefly the precautions are: 1, Keep all bins well ventilated. 2, Examine frequently for toughness or increase in temperature. 3, Move the affected grain without mixing the unaffected, if possible. 4, Farmers with damp grain in store must examine frequently."

Beet Webworm

Sometimes in the Winnipeg area during early July clouds of small moths fly up when they are disturbed in garden and field. These are the adults of the beet webworm. This insect occurs throughout the prairie provinces. The larvae feed upon almost all garden plants including sugar beets. They do not harm fields of grain although they are very fond of certain weeds growing in these fields. When fully grown the larvae migrate in countless numbers and it is at this time that they are noticed

and frequently confused with the army-worm.

When larvae are first noticed, plants should be sprayed with 1½ pounds of arsenate of lime to 40 gallons of water. Do not use this spray on plants where the parts above ground are to be used as food. Migrating larvae may be stopped by trenching. This method of control may be used to protect a garden which may be ruined in a matter of days by an invasion of larvae. Use a poisoned bait made from 50 pounds of chopped up weeds or plant tops relished by the larvae mixed with one pound of arsenate of lime or paris green. Dampen the carrier first and then dust the poison on the chopped carrier and mix well. Scatter this prepared bait thinly along the trenches.

Blister Beetles

Several species of blister beetles occur on potatoes, caragana, beans, legumes, etc. Some are metallic in appearance, others black and others grey. The larvae of some species feed upon grasshopper egg pods and are beneficial in that stage. The adults may be repelled by spraying infested plants with arsenate of lime at the rate of 1½ pounds to 40 gallons of water or by dusting with a mixture of 10 pounds hydrated lime and one pound of arsenate of lime. This is specially useful on potatoes where the grower wishes to control Colorado potato beetle also. Pyrethrum insecticides are also recommended and should be used as directed on the container This insecticide is advised where the blister beetle is the only insect to be controlled.

Aphids

Aphids are frequently very prevalent on many different kinds of plants. They are those soft-bodied insects, usually green or reddish, which occur on the under sides of the leaves of plants and also where new growth is most in evidence. Nicotine sulphate 1½ teaspoons, soap one ounce, and water one gallon mixed together and sprayed directly upon the bodies of these insects will control them very effectively. A dust made from two teaspoons of nicotine sulphate and three ounces of hydrated lime is equally effective.

For the identification of insects and for suggested control measures send specimens to the Department of Entomology at your nearest University or to the nearest Dominion Entomological Laboratory.—Prof. A. V. Mitchener.

Clover Seed Chalcid

The latest unwanted guest in our farm economy is the clover seed chalcid, a very tiny black insect which develops within the seed of alfalfa. When mature it bores a tiny pinhole in the pod from within. There may be several insects within a single pod.

Dean A. V. Mitchener, of the University of Manitoba, who identified it, states that little is known of its life history and as yet no measures of control can be suggested. From a pint of alfalfa seed pods his laboratory captured some 350 insects in 10 days as they emerged from the pods.

Not previously known to exist here, it is now quite widespread in alfalfa fields in Manitoba. Just how far west it may be found is not known at this writing.

Its presence is easily recognized by the small holes in the seed pods.

Rat Control

"There are several kinds of poisons used, most common of which are red squill, strychnine, barium carbonate, and phosphorous. The latter creates a fire hazard so it is not recommended. Red squill is one of the better poisons because it will not harm other animals or humans, but it has a fault in that it has a distinct flavor which rats soon learn to recognize. Strychnine has the same fault. Barium carbonate, although poisonous to other animals as well as rats, likely can be used most successfully.

"After the granary, or rat hideout has been gassed, Mr. Parten suggests the setting up of a 'rat feeding station' near the place. This consists of a small box with a hole on each end in which there has been placed a little pile of poisoned ground meat, or cheap salmon and a little pile of peanut butter with which the poison has been mixed.

"Over the box under which poisoned bait has been placed, place a second box

also with a hole at each end, and on that box put a heavy weight so dogs or other animals can't knock it over. Then pile against the box all manner of junk so that the station looks like a junk heap.

"Such feeding stations should be examined every three or four days, the bait supply replenished and the dead rats taken out. The dead rats, however, serve a very useful purpose. The rest of the rat population seeing a few of their number dead decide that life on this farm has become a little too dangerous, so they move on.

"'Rats are smart, and to catch them you just have to be smarter than they are. For example, we recommend hamburger or cheap salmon as bait because we know rats, if given a chance, will balance their diet. They have eaten so much corn by the time the bait station is put out for them that they are tired of it. They want meat and so we give them meat. On the other hand, if rats are baited around a packing plant I would put poisoned cornmeal or some other poisoned cereal bait in the box'."

Identifying Rootrots

Rusts attack the stems and leaves of crops; smuts destroy the heads and kernels; rootrots attack the seeds, the roots and the basal portions of the grain plants. They are chiefly due to fungus attacks. It is too late this year to do anything about rootrots but if any of them are present they should be identified so that preventive measures can be taken next spring. The following will help to distinguish them:

Take-all is principally a disease of wheat and is confined mainly to the park country and wooded areas. Barley and rye are seldom, and oats never, seriously injured by take-all in western Canada. This disease may appear in rather large patches in the second or third crop after breaking; whereas, in breaking or in older fields, the affected plants are found scattered throughout the crop. The disease becomes evident from the late seedling stage through to maturity. The most characteristic symptoms are stunting of the plants, bleaching of the leaves, with blackening and decay of the roots and crowns. Frequently heads are not formed, but where formed, the grain is usually shrunken. Diseased plants are easily pulled from the soil, as the roots are decayed and brittle. Under very dry conditions only, the seminal roots may be blackened, but even in such cases the yield is considerably reduced.

Browning rootrot is primarily a disease of wheat which is conspicuous in June in the summerfallow crop. There is good evidence that other cereals may be affected. When the seedlings are from 4 to 7 weeks old, the lower leaves rapidly turn brownish and die. The plants appear to cease growing and are actually greatly retarded. This rootrot usually appears in large patches, frequently involving most of the field. Its appearance suggests the term "browning." The progress of the disease is greatly influenced by weather and cultural conditions. When the diseased seedlings are examined carefully, it will be seen that the tips of many of the crown roots are decayed. The seminal or first roots of the same plants would be severely affected also, but this is not so evident to the naked eye. Other basal parts are usually free from discoloration. Later in the season the diseased areas of the field show a thin stand. In addition, the plants are retarded and stunted. This results in a more abundant weed growth. The retarded growth delays harvesting, exposing the crop to further hazards such as rust and frost.

All cereal crops, wheat, oats, barley and rye, are subject to common rootrot. It appears as conspicuous brown discolorations of the roots, crowns, and stem bases. Many young seedlings are killed before reaching the surface of the soil. If the infection is severe, seedlings may be blighted at later stages. Hence blank spaces in the drill rows may be indications of this trouble. It should be remembered, however, that poor germination, uneven seeding, insect injury, and so forth, may also cause an irregular stand. In older plants attacked by common rootrot, the base of the stems and roots show brown discolorations. Frequently this will result in premature bleaching, followed by the killing of tillers or the entire

plant. It should be mentioned that the common fungi associated with this type of rootrot may also attack the aboveground parts, including the head and seed. Consequently these fungi may be carried by the seed. Heavily infected seed, particularly of wheat and barley, usually shows distinct brown discolorations.

It is suspected that prematurity blight is related to the rootrots. It has been observed in wheat and oats. As the name suggests, the plants are blighted rather rapidly at about heading time, when the rest of the crop is still green. The bleached and blighted individuals are very conspicuous. The entire plant is affected, and while it is of normal size and shape, seeds are not formed. The base of the stems and roots are not noticeably discolored. Such characteristic symptoms make it possible, as a rule, to distinguish this trouble from the well-known rootrots. Observations have shown that the course of the disease is somewhat of the nature of a wilt. The exact cause of the trouble, however, is not definitely known.

Controlling Root Diseases

Research on the control of root diseases of small grain crops, particularly wheat, carried on at the Dominion Laboratory Plant Pathology, Winnipeg, Manitoba, has revealed that date, depth, and rate of seeding are factors that markedly affect the development of seedling blight and root rot, states F. J. Greaney.

Early planting of spring wheat gives the crop a chance to develop well during the early spring when the weather is cool and the soil generally moist. Fortunately, these are exactly the conditions that are unfavorable for the development of the parasitic root-infecting organisms. Numerous trials to determine the effect of seeding dates on the occurrence of seedling blight and root rot have all favored early seeding. Each year, during the five years, 1935-39, early seedings of wheat resulted in more rapid and vigorous germination and seedling growth, less seedling blight and root rot, and higher yields.

The depth at which wheat is sown is important in guarding against severe attacks of seedling blight and root rot. Field tests and observations made over a long period of years have indicated that deep seeding is exceedingly favorable to destructive attacks by the parasitic soil-borne root-infecting organisms. Consequently, wheat and other small grain crops should not be sown too deeply. In this connection it may be mentioned that the spring preparation of the soil should consist of shallow working to preserve a firm moist seed bed, and to make possible a uniform seeding depth.

The rate at which wheat should be sown depends upon several factors, the most important of which are the type of soil and the moisture condition. However, in regard to the relation of seeding rate to root rot control, it was found in extensive field tests that thickness or thinness of sowing exercised a considerable effect on the percentage of plants that become infected with root rot. For example, in experiments at Winnipeg during 1939, the percentage of plants infected with root rot from wheat sown thinly was 69, while that of wheat sown thickly was 97. As a matter of fact, any condition that increases tillering seems to lower the percentage of plants that become severely infected with root rot.

Guarding against root diseases of wheat, and other small grain crops as well, is a matter of using sound disease-free seed of the best varieties and providing good growing conditions. Finally, good cultural practices should be followed in regard to tilth, soil fertility, and early sowing at the proper depth and rate.

Loss in Sweet Clover Stands

Attention is called by the Dominion experimental farm, Brandon, to the fact that in Manitoba, the acreage of sweet clover decreased by 33 per cent in 1942, as a result, principally, of the poor stands of this crop caused by the sweet clover weevil and root rot. Newly emerged stands of sweet clover are frequently destroyed, and even year old clover is attacked during the spring

and early summer months, the damage arising from the fact that the weevil eats crescent-shaped notches in the leaves.

Where not injured by the weevil and root rot, sweet clover grows well on most types of soil. Like all other clover and leguminous plants, nitrogen is added to the soil wherever sweet clover is grown; and as a feed for livestock it is very useful in balancing rations because it has a high protein and lime content. The protein is the most valuable of all feed elements since it is necessary for growth and the best development of the animal, while lime is essential for bone development.

Brandon officials have found that the weevil migrates in large numbers from old stands of clover to new stands nearby. Consequently, they suggest that new seedings should be made as early in the spring as possible, in order to give new stands a good start; and also that these should be sown as far away as practicable from the older seedings.

Crown Rot of Alfalfa

In recent years a new disease of alfalfa has appeared in the central and northern parts of Alberta and Saskatchewan, especially in the grey-wooded and transition soil areas. In some cases in 1941, the disease was so serious that it resulted in a fifty per cent killing of the stands.

The damage occurs in the early spring and is, therefore, sometimes confused with winter killing. The killing occurs in irregular patches on slopes or in hollows and the bare patches may develop quickly, or slowly over several years. If the dead plants are examined after being dug up, they will show dark-brown, rotted areas at the crowns and sometimes on the roots. This means that when the crown buds are destroyed by the disease the plant cannot continue to grow.

Crown rot of alfalfa is caused by a fungus which grows at low temperatures. It lives in the soil and attacks the plants about the time of the first spring thaw. After the soil warms up and the plant starts to grow, the development of the disease ceases, though the fungus remains dormant in the dead plants and begins to develop again the next spring.

M. W. Cormack, Dominion laboratory of plant pathology at Edmonton, states that field tests show all varieties tested of alfalfa, sweet clover, common clover, winter wheat and a number of grasses as being completely killed in the early spring. He therefore advises that "when an alfalfa field is plowed up because of severe crown rot damage, it should not be seeded down to these crops for at least three years. Spring-sown cereals, or other non-susceptible annual crops can be grown. The fungus may be carried to a healthy field in soil or machinery. Unfortunately, most of the existing varieties of alfalfa are highly susceptible, but attempts are being made to select resistant plants from severely damaged fields, in the hope of developing resistant varieties. Growers can assist greatly by notifying this laboratory of diseased fields of alfalfa in the early spring."

Ergot

Since ergot is a disease which affects some cereals and many grasses and is poisonous itself if eaten by livestock, it is important to guard against it in feed.

Ergot is caused by a fungus which attacks the plant while it is in the blossoming stage. The fungus grows and ultimately forms large masses in the place where the grain or seed should be. These masses are dark and horn-like in appearance and may be several times the size of the normal grain.

A statement from the Saskatchewan department advises that ergot be removed from all infected grain, by the use of the fanning mills, before the grain is fed. Occasionally, the ergot masses are broken up in handling the grain, in which case the only course open is to handpick the ergot from the grain, or float it off in a solution of salt. If 40 pounds of salt are dissolved in 25 gallons of water, and the grain placed in the solution, the ergot will float after stirring well and can be skimmed off. It is advisable, however, to wash the grain in clear water after using the solution, to remove the salt.

This is tedious, of course, but it is better than wasting the grain or losing valuable livestock. The ergotted rye, if sold, will be graded "rejected."

Using clean seed, free of ergot masses or particles, and the avoidance of the same, or other ergot infected crop, on the same land two years in succession, will provide a fairly effective preventive Nearby grasses should be cut frequently as they are a common source of infection.

Prevent Development of Ergot

Grass along roadsides and headlands, if mowed while still in the blossom stage, will not assist in spreading ergot. Following one susceptible crop with another helps to spread it and should be avoided where possible. If the ergot-infested ground has been plowed prior to spring working the ergot bodies will have been buried and prevented from producing new spores.

Flax Rust

All the varieties of flax generally grown are susceptible to rust, but Redwing, for example, suffers less than Bison. The plant breeders at the Dominion Experimental Farm, Ottawa, are working with the more resistant varieties, making crosses of them and studying the rust reaction of the resulting progeny, in the hope of discovering newer varieties with high resistance to all forms of flax rust.

Even a moderate infection of rust will cut down the yield, owing to the fact that attacked plants lose some or all of their leaves. Bright or orange postules appear on the leaves and stems; and later in the season the spots turn darker, when the brownish spores that winter over on the straw make their appearance. The disease attacks only flax and since new infection comes from the stubble and straw of the previous year, a rotation that avoids sowing flax on the same plot and for two years in succession, is recommended.

Corn Smut

Corn smut can be recognized easily by the characteristic greyish boils which may appear on any part of the corn plant and which, as they ripen, become filled with a mass of black spores. When mature, a boil breaks open and the spores fall to the ground where they germinate and later form new spores which blow about infecting other corn plants.

The disease is very difficult to control since it attacks the growing tissue of the plant at any time throughout the season when conditions are favorable. Dry weather holds the disease in check but following wet weather it spreads rapidly. Seed treatment is of little value, except when corn is to be sown in a district where the disease is unknown, as most of the infecting spores come from the soil. If the crop is to be used for ensilage most of the spores are killed after being three or four weeks in the silo. A crop rotation in which corn does not follow corn is helpful but the growing of corn for two or more years on the same land tends to increase the smut organism in the soil.

Control of Cereal Disease

There are more than 20 diseases attacking cereal crops such as wheat, oats, barley, rye and flax. Taken together, these diseases are so common that many farmers, it is to be feared, pay little, if any, attention to them, and conclude at the end of the season that any disappointment in yield is due to lack of moisture at the right time or some other factor they are not quite able to explain. Loss from diseases, if it could be computed accurately, would be staggering. A loss of only one bushel per acre, for instance, in wheat alone at present prices, would mean close to 20 million dollars per year for the three prairie provinces. When all 20 or more diseases are considered, involving the total acreage sown to cereal crops, and also remembering that the loss in some cases may be almost the total crop, the dollars and cents cost of cereal diseases can be imagined.

Control measures are roughly of three kinds. The first, and probably the most important is good farming, which involves good tillage methods, the maintenance of soil fertility, the use of well

matured, clean seed, put into the ground at the right time. The second means of control is secured through the breeding of disease resistant varieties. This is a slow method in which considerable progress has already been made, but for which the farmer must depend on the plant breeder. The third method is the treating of seed for the control of specific diseases.

Examples of control by good farm practice are numerous. In the case of crown rust of oats, it is not only advisable to eradicate any nearby buckthorn shrubs, which are alternate hosts to the disease, but to sow oats early in order to mature them early before the disease becomes severe. Control of flax rust is assisted by keeping following flax crops away from where a rusted crop has grown. Also by plowing down rusted flax refuse and cleaning seed well to remove bits of rusted straw. Heat canker of flax can be guarded against by early and thick seeding in rows running north and south, while Stem Break, or "Browning" of flax is less likely if crops are rotated. Similarly, that form of root rot on wheat, barley and some of the grasses known as Take-all, mainly found in patches in black soil areas where second, or later wheat crops after breaking are being grown, is warded off as a rule by a rotation of crops and maintaining soil fertility at a high level; and common root rot, which infects most of the cereal crops, has no specific control, but early, shallow seeding of sound seed, and the maintenance of soil fertility are beneficial.

Diseases for which there is no known control except the use of resistant varieties include stem and leaf rust of wheat, and the stem rust of coarse grain crops. Flax wilt is in the same category, Bison, Redwing and Royal being more resistant than most other varieties. Royal flax is also more resistant to rust.

Diseases requiring treatment of the seed are numerous and fall into two groups. In the one group, containing principally the loose smuts of wheat and of barley, the disease is carried inside the seed. Consequently it is desirable to obtain seed free from these diseases; or, a seed plot may be sown isolated from other crops of a similar nature, and all smutted heads picked as promptly as they appear, placed in a paper bag and burned. The disease is conspicuous in the field, but is not evident in the threshed grain. For these loose smuts, a hot-water treatment can be made effective, but is not very practicable, since small lots of seed must be soaked in water for four hours, dipped for two minutes in water at about 120 degrees temperature, and then placed in water at a temperature of 129 degrees for wheat (128 degrees for barley) for a period of ten minutes, after which the grain is spread out to dry.

A larger group of diseases are carried by means of spores which are picked up by the seed during threshing, or afterward. This group includes the bunt of wheat (covered or stinking smut), covered smut of barley, the covered and loose smuts of oats, and the stem smut of rye, as well as barley stripe and halo blight of oats. These can generally be controlled by treating the seed either with mercury dust or with formalin. Formalin is an effective treatment, but may injure the seed, especially if the germination is not too strong, and the seed is rather weak. Mercury dust, such as Ceresan, Leytosan, or Lunasan should be used according to the directions printed on the container. The rate is generally one-half ounce per bushel of grain, and the use of a dusting machine is required. Where formalin is used, it may be sprinkled on the grain, or the grain may be dipped in the solution. Where sprinkling is followed, one pound of formalin is used to each 40 gallons of water. A gallon of this solution is used to each bushel of seed, and is sprinkled onto the grain, either in a suitable type of machine, or while the seed is being turned over with a shovel. After sprinkling, the grain should be covered with clean sacks for four hours, and then spread out to dry.

Where the grain is dipped in the solution, one pound of formalin is again used with 40 gallons of water. Not more than a bushel of grain is put in a sack, tied loosely and dipped in the formalin solution for five minutes, then drained, piled on a clean floor, covered for four hours, and spread out to dry.

Mercury dust may be used to control

bunt of wheat, covered smut of barley, covered and loose smuts of oats, head and kernel smut of millet, stem smut of rye, head smut of grasses, stem break or browning of flax (where necessary), barley stripe or halo blight of oats, and is also advisable in the case of seed injury of flax in order to assure good germination.

The formalin sprinkling method may be used for bunt of wheat, or covered smut of barley, covered and loose smuts of oats (not hulless oats), head and kernel smuts of millet (cover for two hours only and dry quickly), stem smut of rye.

The formalin dipping method is satisfactory for bunt of wheat, covered smut of barley; and for the head smuts of grasses where covered only for two hours.

In addition to the rust, smut and root rots, there are certain seed troubles sometimes induced by disease. Drought, rust and rootrot may induce thin and shrunken seeds, which, in turn, will produce weak seedlings. Before seeding such grain, the thin kernels should be removed with a fanning mill and treatment with mercury dust is advisable. Deep seeding should be avoided.

Where seed may have been injured by frost, germination tests are particularly useful, especially with barley and flax. Frost-injured wheat is shrivelled, blistered and wrinkled, and generally shows a green coloration. In oats, frost injury is frequently indicated by a dark color in the crease, best seen after cutting the kernel crosswise. Frosted grain for use as seed may be benefited by a mercury dust treatment, and an increased rate of seeding may be desirable. If the seed of wheat and barley has a brownish discoloration at the germ end, the trouble is known as smudge, and may be caused by the fungus responsible for common rootrot. If so, a mercury dust treatment is advisable.

Farm Machinery

Economy in Trucks and Tractors

AGRICULTURE in western Canada has been developed to its present status by an efficient application of power. It is true that soil, climate, and science of agriculture have all played a large part in the development of western agriculture, but the use of power and plenty of it, has been fundamental.

Horses are the most economical power for rolling, rough land, or for land which is soft, or cut up in irregularly shaped fields. Good horses well harnessed, attract the young farmer who loves horses, and will not only be a pleasure to work, but will also build up the personal pride so essential to the satisfied operator. A few good horses, well broken by use on the farm, will also serve as a source of revenue when placed on the market. The sale of a good type of draft horse grown and trained on the farm, will tend to lower the net cost of horse power. All farmers who love to raise and work with horses, will find the horse, when worked in economical units a valuable form of farm power. A very good combination for farm power is the use of one or more well balanced horse teams for drawbar work and one or more tractors of the type to suit the farm, depending upon the size of the farm, to help out with the drawbar work during the rush seasons and supply the belt power required.

There are three types of tractors on the market which are each quite efficient in their place. A knowledge of the characteristics of these tractors is essential in order to compare them in a practical way.

The *high compression* tractor has been designed so that more power can been developed by the engine per cubic inch of displacement. The high compression engine also develops the power with less fuel. The high compression engine, however, requires fuel which will burn without detonation for best performance. There are two tractor fuels on the market suitable for the high compression tractor. First, purple medium octane gasoline of about 53 to 60 octane. This fuel is not treated with lead and will operate in any high com-

pression engine efficiently at loads where pinging or detonation does not develop. Second, high octane purple gasoline which has been leaded. This fuel is 68 to 72 octane and is required in the high compression tractor operating on loads where the non-leaded gasoline pings, or detonates. A fuel which detonates continually cannot provide satisfactory engine performance.

The *medium compression* tractor is not designed with sufficient compression to take advantage of the high octane fuels. Low octane fuels, such as a purple tractor gasoline, or purple tractor distillate, develop the maximum power of the tractor without pinging or detonation. All test data indicate that the fuel costs when burning distillate is less than when burning tractor gasoline. This is true only when the tractor is conditioned properly and so operated that the distillate is burned without abnormal smoking at the exhaust, or excessive fuel dilution in the lubricating oil.

The medium compression tractor operating on distillate may, or may not, require more maintenance than when operating on gasoline. The cost of maintenance is only partly associated with the fuel used. The general care given the engine, along with the operating conditions, will largely affect the maintenance.

The cost for lubricating oil may be slightly higher when burning distillate than when burning gasoline, particularly where the oil is discarded at each filling: the cost will not be higher where the oil is strained regularly and used over again.

The *Diesel* engine is considerably more efficient than either the high compression gasoline engine or the medium compression engine. The belt power is developed for less than half the cost of the gasoline, making a saving of 46 per cent with non-leaded gasoline and 52 per cent when using leaded gasoline, while a saving of 36.8 per cent is made in the cost of the fuel per horse-power hour, when compared with the distillate tractor.

The cost of maintenance and repairs, as well as the depreciation of the Diesel engine, has not proven to be more than for the ordinary gasoline, or distillate burning tractor. The operation of the Diesel tractor requires a little more care. The fuel must be clean and of the proper grade, to ensure flow through the filters and supply fuel pump lubrication. Dirty fuel not only clogs the fuel filters, but causes excessive wear of the fuel pump, which is expensive. The temperature of operation should be uniform, maintained above 160 degrees Fahr., for complete combustion, which is indicated by smoky exhaust, may cause trouble and must be avoided.

The first cost of the Diesel tractor is higher than the gasoline and distillate tractors. Consequently, the purchaser of the Diesel tractor must have annual work enough to pay the extra first cost, from the fuel saving in two to three years, so that the tractor may make a net profit for the owner from the fuel savings before extensive overhauling is necessary. The fuel saving for Diesel operation can be estimated reasonably accurately by taking 46 per cent of the gasoline cost for the gasoline tractor and 36 per cent of the distillate cost for the distillate tractor.

Since most of the power used in the production and marketing of grain is power for pulling implements, or drawbar power, *it is important to study the fuel costs for traction equipment, such as tractor with steel wheels, with rubber tires and with crawlers.*

Steel wheels with spade lugs were standard equipment on the farm tractor for many years. The wheels gave some trouble in not cleaning, in clay soils. Where scrapers were used, considerable power was lost. Extension rims, with a wider spacing of the lugs, assisted in cleaning with less loss of power than with scrapers.

The rimless or open type wheel has been developed primarily for row crop work, where cleaning was difficult. The open type wheel cleans in most soils, since there is no rim to retain the soil against the lugs. It does not pack the soil as much as the rim type steel wheel. It also provides better traction, where more penetration than the length of the lug is required.

Rubber tires have become almost standard equipment on tractors, during the past five years. Eighty-five per cent of the tractors sold in Canada during 1941 were equipped with rubber tires.

Tractors fitted with rubber tires develop more power through the drawbar, than the same tractor on steel wheels. Data from tests indicate from 15 to 32 per cent more power on rubber than on steel wheels.

The wheels and tires need to be loaded with cast iron weights and liquid, so that traction may be had to keep the slippage below 10 per cent, if greater power is to be had without excessive wear. The hitch on the tractor should be high and on the implement low, so that as much weight of the tractor and load as possible be placed on the rear wheels of the tractor.

is to be had without excessive wear. The hitch on the tractor should be high and on the implement low, so that as much weight of the tractor and load as possible be placed on the rear wheels of the tractor.

Tractors fitted with rubber tires operate with a saving of fuel from 17 to 30 per cent over that of steel wheels, the economy depending somewhat upon the type of work and the slippage.

Tractors are fitted with tires sufficiently large for *normal rated performance*. Research has proven that the use of the oversized tire alone does not improve traction and reduce slippage. The oversize tire has an advantage in rolling land where slippage with standard equipment is high because of the inability to load the tires sufficiently. The oversized tire will hold more weight of liquid and also carry the cast iron weights without overload. Consequently, *oversized tires are only an advantage for conditions where more weight is required to reduce slippage, and where considerable severe and maximum performance is required.*

Rubber tired equipment has also improved the riding conditions for the operator; it has reduced the shock upon the tractor, and has reduced the dust which is raised when in operation.

Research work reported from Washington, D.C., indicates that rubber equipment packed the soil 32 per cent more than when using steel wheel equipment. Where packing the soil is detrimental, this factor should be considered.

Rubber tires cost more than steel wheels and lugs. The accompanying fuel costs are calculated from tests and indicate the saving in fuel which will result from the use of rubber equipment. There should be sufficient annual work so that the rubber equipment will pay for itself in the first year or two.

There have not been many farm tractors equipped with crawler equipment, until the development of the small sized tractor of the crawler type. Many crawler tractors of all three types—gasoline, distillate and Diesel, have found an economical place in power farming in the West.

The crawler tractor operates in the field with far less slip than any other tractor, the average slippage for field work varying from one-half to one per cent slip, up to three and four per cent, as compared with the steel wheel equipment operating from five to ten per cent slip and the rubber tires with from six to 16 per cent.

The crawler tractor operates on from 9.5 to 24 per cent (averaging 16 per cent) less fuel than the tractor with steel wheels. It also packs the soil less than any other type of tractor. Research data indicates that in one series of tests, packing with the crawler tractor was 39 per cent less than with steel wheels and 83 per cent less than with rubber tires. Where the soil being worked is seriously affected by packing, the advantages of the crawler tractor should be considered.

The crawler tractor has definite advantages in loose top soil over the steel wheel tractors and on rolling land over both the steel wheel and rubber equipped tractors.

Experience has shown that the first cost of machinery and tractors for power, tillage, seeding and harvesting, is high for the average small farmer. There has been a marked reduction in cost, by working more than one shift with the farm tractor, on both tillage and seeding operations. In some instances where weather conditions were favorable, night work has been successful in harvesting.

The modern farm tractor has been fitted with well-designed lighting systems which have made night work quite

SUMMARY OF TRACTOR FUEL COST PER HORSE-POWER HOUR
(Based on the Nebraska Test and Fuel at Saskatoon Prices.)

Fuel	Cost per Gallon Cents	High Compression Cents	Medium Compression Cents	Diesel Cents
For Belt Work:				
Leaded Gasoline	24.8	1.79	—	—
Tractor Gasoline	21.3	1.62	1.85	—
Distillate	17.3	—	1.36	—
Diesel Fuel	14.8	—	1.16	.87
For Drawbar Work with Steel Wheels:				
Leaded Gasoline	24.8	2.89	—	
Tractor Gasoline	21.3	2.75	2.87	—
Distillate	17.3	—	2.08	—
Diesel Fuel	14.8	—	1.81	1.29
For Drawbar Work with Rubber Tires:				
Leaded Gasoline	24.8	2.32		—
Tractor Gasoline	21.3	1.96	2.19	—
Distillate	17.3	—	1.56	—
Diesel Fuel	14.8	—	1.27	0.94
For Drawbar Work with Crawlers:				
Leaded Gasoline	24.8	2.19	—	—
Tractor Gasoline	21.3	1.88	2.59	—
Distillate	17.3	—	1.84	—
Diesel Fuel	14.8			1.04

efficient. Many have replaced two slow-speed tractors with one high-speed tractor fitted with a lighting system, so that the tractor and equipment could be operated 24 hours per day instead of 12 to 16 hours, which was about the limit of the tractor without lights.

On the larger farms, the Diesel tractor has been used to draw units in tandem, thus increasing the area covered per tractor and per man, per 24 hours. This practice has definitely reduced the cost per acre for tractor and machinery.

The farm tractor has not only been designed for efficient traction and belt work, but is also designed to operate machines by the power take-off drive. That is, the tractor will draw the machine and also operate it at the same time. The power binder and power-take-off-driven combine are examples of machines of this type.

The use of the power binder has increased the area harvested by one binder and one man. The rubber equipment on both the binder and the tractor not only increased the average cut per day and year, but also reduced the cost per acre.

The use of the combine harvester for cutting or picking up and threshing the crop, completed the picture for the tractor farmer, who was convinced that farming without horses was desirable. The tractor combine and truck eliminated the need for horses in the harvest and also replaced the many harvest hands, which had proven to be costly and unreliable.

The large slow-speed combine is gradually being replaced with the small rubber-mounted high-speed power take-off driven machine. The small machine costs only slightly more than the power binder and does the work of both the binder and the thresher. The power-take-off-driven combines are of large capacity for the width of cut. They are designed for high speed. The combines may be used to cut the standing grain, or pick up grain which has been dried in the windrow. Both large and small combines are fitted with grain hoppers or tanks holding from 30 to 85 bushels of grain respectively. Most of the grain

is hauled from combines or the thresher in trucks. This is particularly true when the grain is hauled directly to the elevator from the combine.

The truck most suited for general farm hauling, as well as grain hauling, is the smallest truck which will carry two dumps from the small combine (60 to 90 bushels), or one dump from the large combine, which is from 60 to 90 bushels. Actually, there are trucks of many sizes used on the farm. The light half ton, the three-quarter to one ton, the one and a half ton and the two ton trucks.

The light half-ton truck is used more as a light delivery, or run-about truck for farm service, than for grain hauling. Extension boards are placed so that 30 to 40 bushels of wheat can be hauled. This is not very satisfactory for hauling any distance, since there is not time to get back into the field before the combine has threshed 30 bushels and is waiting. A somewhat larger truck is more economical and serviceable.

The three-quarter to one-ton truck should not carry more than 50 bushels. This truck is a little small for two dumps from the small combine, and also is small for a single dump from the large combine. The three-quarter to one-ton truck is of proportionately lighter construction than the 1½-ton and two-ton trucks. This truck is really only a three-quarter-ton truck and should never be loaded with more than 100 per cent overload, which is 50 bushels. Those hauling more than 50 bushels experience abnormal breakage and wear.

The 1½-ton truck is ideal for farm hauling. A load of 90 to 100 bushels will always hold two small combine dumps and one large combine tank full. There is, however, a discrepancy as far as this size of truck is concerned. Most of the 1½-ton trucks are the two-ton, without the overload springs, or the dual wheels. The cost of this truck is considerably higher in proportion than the three-quarter-ton truck. Many farmers put on the overload springs and extra tires in order to take advantage of the extra carrying capacity of the truck, since so equipped, it can carry 150 to 160 bushels. Where long hauls are being made, a truck of this capacity is quite efficient. It will hold two dumps from the large combine and three or four from the small combines. Portable field hoppers are sometimes used to hold the extra dump while the truck is away.

Unless there is more heavy duty hauling than the grain, it is questionable as to the economy of owning the two-ton truck. There are some who do enough custom work to make the larger truck a profitable investment.

A study of the trucks used for agricultural hauling reveals a great many old trucks of low capacity, which are not operating particularly efficiently. However, there are a great many trucks in service which are fitted with the modern 6 or 8-cylinder high-compression engine. These trucks are designed to operate efficiently on either Grade 1—78 octane, or Grade 2—70 octane gasoline. When operating on 78 octane fuel, the ignition is set up so that both the extra horse-power and economy are available. This setting is only necessary for heavy duty work.

The farm truck is probably the most abused of all farm equipment. It is used on the road as a car; it is used for short work where much starting and stopping is required, and then it is overloaded continuously and driven at high speed during the grain-hauling season. The farm truck is not used like the tractor, where regular servicing, such as greasing and maintenance is done. The service to which the truck is subjected is reflected in the cost of maintenance and repair. Where the truck is serviced regularly and is not abused, the cost of operation is remarkably low.

The following figures are taken from the record of a typical farm truck which was operated 70,000 miles in 12 years in farm service:

Depreciation, $91.66 per year; total tire replacements, $172.00; cost of repairs per year, $29.88 (labor not included, work done on farm); fuel cost per mile 1.95 cents; oil cost per mile .08 cents; fuel and oil cost per mile 2.03 cents; depreciation and maintenance, 2.33 cents; total cost per mile, 4.36 cents.

It is of interest to note that the cost of fuel and oil for truck operation is about one-half the total operating cost; and it should be noted that the cost of

four to five cents per mile for truck operation, in farm service, is not high —Professor A. E. Hardy.

For High Speed Tractors

Extensive experimental work on the effect of speed to farming machinery has been conducted at the Dominion Experimental Station, Swift Current, Saskatchewan, writes G. N. Denike. The results indicate a very marked increase in draft or power required to pull slow speed tillage implements at these higher speeds. Every increase in speed of operation causes a proportionately greater incauses a proportionately greater increase in power required which makes it necessary to work at a shallower depth or cut down on the size of implement used.

The experiments have shown definitely that high speed implements are essential to an economical set-up where high tractor speeds are used. The draft of the plow with quick turn moldboards, designed for speeds of two to three miles per hour, increases by as much as thirty per cent, from 2.5 to 3.5 miles per hour, while the use of slow-turn moldboards designed for the higher speeds of 4.5 to 6 miles per hour will result in only a 15 per cent increase of draft at 5.5 miles per hour over that of the quick turn boards at 2.5 miles per hour. The effect of using slow speed implements at high speeds is particularly noticeable on the resulting tillage work. Practically all tillage implements are pulverizing machines, designed to do just the correct degree of pulverization or soil disturbance at a definite speed, with the result that higher speeds increase the pulverization to a disastrous degree. Machines designed for high speed operation will give the desired degree of tilth as well as stand up better under high tractor working speeds.

The advantages of increased speed were brought out forcibly by these experiments where the correct combination of tractor and implement was tested. Maximum economy can be secured from farm power only when it is operating as near maximum load as possible, in any gear. Increased speed results in either a greater acreage covered per day or in lower overhead by reducing the size of equipment necessary to do a given amount of work per day.

Seeding and harvesting work may be done in a very satisfactory manner without change of equipment at higher speeds. The seed drill does a better job of seed distribution at speeds above 4.5 miles per hour than below this speed. Seeding with the standard drill equipped with single or double disc furrow openers has proven satisfactory at speeds of 6 to 6.5 miles per hour.

High speed combines with cutting bars from forty-two inches to eight feet in width, selling at from one-third to one-half the price of larger slow speed machines result in practically equal daily acreage covered at considerable saving per acre and greatly reduces the equipment overhead.

The use of slow speed machinery with high speed tractors results in excessive wear to the equipment, uneconomical use of power and produces very unsatisfactory and even disastrous tillage, seeding or harvesting results. The correct combination of high speed implements and tractor will produce desired farm work at reduced overhead and operating cost with the additional advantage that work may be completed at the correct time.

Weighting Tractor Wheels

TRACTOR users very quickly found that light, general-purpose tractors with air tires needed additional weight on the rear wheels to develop the proper drawbar pull for plowing, discing, and other heavier draft operations. Tests reported in Nebraska Bulletin 291 show that the pounds pull of an air-tired tractor can be increased by about 54 per cent of the added weight, and that the drawbar horsepower can be increased in about the same proportion. This extra weight is unnecessary and a deteriment, because it tends to pack the soil for such light draft operations as harrowing, planting, cultivating, etc.

To be practical such extra weights must be easily put on and off, should

not be expensive nor deteriorate easily, and should be applied to the wheels rather than on the tractor so as not to put unnecessary stresses on the tractor itself. One of the most common methods is to fasten 150-pound cast iron weights on the outside of the wheel, the first one being bolted to the wheel spokes, while the next ones are bolted to the first weight. 150 to 450 pounds may be used on each wheel depending on the additional traction needed, which under normal conditions should increase the draw-bar pull from 160 to 480 pounds. These cost from $40 to $48 for a set of six, will stand hard usage, and can be changed easily by an able bodied man or by a boy, with a rope and bar. Some try to save in the first cost by using concrete instead of cast iron removable weights. Since concrete weighs only 150 pounds per cubic foot instead of 450 pounds for cast iron the concrete weights must have three times the bulk of the metal ones, which means increased thickness and sticking out in the way or increased diameter with danger of breaking if not carefully handled.

Water is also much used in tractor tires for securing increased traction. The advantages claimed for this method are low cost, a cushioning effect which reduces bouncing, no weights to handle or transport, no projecting wheel weights, lower centre of gravity, and placing the extra weight where it is most effective and removing it entirely off the wheel structures. Ordinarily filling the tire three-fourths full of water will give about the maximum weight desired for that particular size of tire, especially where 20 per cent calcium chloride is added as an anti-freeze for 25 below zero Fahr. temperatures.

At least two large tire firms recommend the use of liquid weights; experiments over two or three years having convinced them that neither water nor the calcium chloride solution has any bad effects on tires or tubes. Tires must not be filled more than three-fourths full of liquid, and the small air volume means that valves and valve caps must fit tightly, and the air pressure be checked frequently. Liquid can be substituted in the smaller sizes of tires for about one wheel weight, in the medium sizes for about two wheel weights, and in the larger sizes for approximately three wheel weights.

Water Inflation for Tires

Water inflation of tractor tires is simplified by a Schraeder hose adapter, and these few simple operations are required according to the tire manufacturer's recommendations: (1) place the tube valve at top without jacking up wheel; (2) remove valve core and allow air to escape from tire; (3) attach hose adapter to valve to hold it in place; (4) jack up wheel so tire is not deflated and maximum amount of liquid can be admitted; (5) to adapter attach hose from water system, pressure tank, elevated tank, or hand force pump; (6) turn wheel till valve is at the desired level and fill with liquid, shutting off the water occasionally and bleeding the air pressure built up as the tire fills, until the liquid runs back out of the valve; (7) remove hose adapter and replace valve core securely, remove jack and inflate tire to recommended pressure. During the filling operation, the flow of liquid into the tire can easily be heard as long as the level is below the valve. As soon as the level goes above the valve the sound heard during inflation stops immediately and tells when to cut off the flow.

To remove liquid from the tire for reducing the weight for light draft or for refilling with anti-freeze solution, much the same method is followed as in the loading process, except that after the hose connection has been made, the deflating plug should be applied to the hose, and the tire inflated to about 35 pounds. Then the tire should be rotated until the valve is at the bottom, with the tractor's full weight on the tire. Then the free end of the hose should be held in a container, the deflating plug removed and the air pressure within the tire will empty it rapidly. If the flow slows up, the tire can again be inflated to 35 pounds. This will remove all but about half a gallon of water, which will not interfere with tire changing or filling with anti-freeze.—I.W.D.

Take Care of Rubber

Rubber is subject to damage from heat, freezing and thawing, direct sunlight and wet. Consequently, rubber sunlight and wet. Consequently, rubber tires should be kept under cover as much as possible and their useful life will be lengthened if they are kept in a cool, dry and darkened shed.

It is a rather strange thing that constant use under the proper loads and at proper speeds will lengthen the life of rubber tires, provided the correct air pressure is maintained at all times. If the tires should be required to stand for any length of time, they should have the weight taken off them and the air pressure reduced. When tires are in storage, the air pressure should be reduced to a few pounds.

When the end of the season comes and the tractor, or rubber-tired implement is not required any longer, the tires should be removed, cleaned and given a coat of some recommended rubber-tire paint or preservative. This will protect them against ageing.

Cleaning Radiator of Scale

Experiments were conducted by Prof. G. Lawson Shanks some years ago with solutions of muriatic acid of varying strengths; with lye and with washing soda. They were the basis for the following recommendations: Use as clean water as possible—rain water preferred. Then use a solution consisting of half a pound of washing soda in four gallons of water, at least once a month to keep deposits loosened. In addition, at least once per season or when necessary, use a solution of one part of muriatic acid to ten parts of water leaving the solution from 12 to 14 hours in the engine standing cold. Lye was found to be generally ineffective. Commercial products for cleaning out scale are on the market.

Handling Your Tractor Oil

After following my tractor instruction book to the letter in the care of my cylinder oil, I suddenly discovered a wrong practice that the book hadn't listed. At the beginning of the second season with my engine, I changed to another brand of cylinder oil. Both products were the same price, but put out by different companies. One was a paraffin base oil, the other was not. Either oil, used continuously, was satisfactory as far as operation, oil pressure, and all around satisfaction was concerned. It was switching from one oil to the other that caused the trouble and indicated to me the necessity of sticking strictly by a particular brand of oil once you have started with it.

The first season the paraffin base oil was used. The second season I started using a non-paraffin base lubricant. At the end of the first one-hundred hours of operation, the third refill of new oil was put in the tractor, changing being done after each fifty hours of operation. In less than ten hours the pressure gauge began dropping. The drop wasn't constant and seemed to depend on the position of the engine. Finally, on a long downgrade, the pressure quit entirely.

On removing an inspection plate in an effort to locate the trouble, an accumulation of carbon was discovered on the floor of the oil pan, completely covering the oil intake screen. Draining the oil and flushing the crankcase removed a quart of loose carbon from the oil pan. It had accumulated while using the first brand of oil; and switching to the second had loosened it and brought it down into the pan in the form of loose carbon.

At the end of the next fifty hours run, the pan was cleaned again and further large deposits of carbon flushed. Little carbon came down after the second flushing.

After that experience, I decided oil companies are right when they advocate continued use of their brand of oil. If you start with a particular brand stick with it; or if you must change, switch to an oil that you are fairly certain is of the same base as the one originally used.

Cylinder oil is the lifeblood of any motor and too much stress cannot be put upon its care and selection. Draining should be regular, preferably done from the pan drain plug and not from the bottom oil level indicator plug. It is also advisable to let the engine

stand idle for a couple of hours before draining down and refilling to the top indicator plug. This gives the oil an opportunity to separate from the dilution which gets mixed with it during regular operation, especially when burning low grade fuels.—Roy E. Stokes.

Purify Machine Oil

It has been estimated that thousands of gallons of lubricating oil are wasted every year on farms of western Canada. This arises from the common practice of draining the oil from a truck or tractor every so often and replacing it with new oil. The wastage is in the old oil which is not entirely worn out.

It is said that oil never wears out, although it may be made unfit for further use in its present state, because it has been contaminated with dirt, carbon from the cylinder gasses and very small quantities of metal from the bearings and the walls of the cylinder. A method for clarifying oil has been used at the Dominion Experiment Station, Swift Current and found very satisfactory. Further particulars as to the construction of an oil cleaner can be obtained by writing to that station, but in the meantime here is a brief description of the method which will undoubtedly be of interest to many of our readers:

"The equipment used consists of two small drums for saving the oil, one large drum made into a cleaner, and another in which to put the oil for further settling. When 18 gallons have been collected, it is put in the oil reclaimer drum and mixed with 18 gallons of hot water to which seven ounces of caustic soda have been added. The oil barrel used as a cleaner has a removable inside mechanism. It consists of a large funnel soldered to a 1½-inch pipe, and five galvanized baffle plates soldered to the pipe. Water is put into the drum and heated almost to the boiling point. Then the oil is poured into the funnel where it passes down the pipe to the lower end. It spreads around the lower baffle plate and rises through the three-sixteenth inch holes drilled in each plate. The holes are staggered in each plate so the oil is thoroughly mixed with water.

"The mixture is kept for 24 hours and then allowed to cool and settle for 24 hours. After settling, the oil will be on top of the water and can be drained off through the tap in the centre of the drum just above the level of the water."

Tractor Reminders

To help give the tractor the long life which was intended for it, here are a few reminders of some of the points most frequently neglected:

Keep the tractor motor clean: Dirt is its worst enemy. Grease accumulates dirt, prevents proper inspection and rots the spark plug wires.

Use clean fuels, oils and greases of the proper weight and grade.

Service the oil cleaner once a day—several times a day when engaged in very dusty work.

Don't start the motor with a load, when it is cold. More than half of the motor wear takes place when running it cold. Frequent starting and stopping is harmful.

Operate the tractor at as near 90 per cent of its rated capacity as possible. Overloading is dangerous.

Check spark plug gaps frequently and keep the ignition system in first class condition at all times.

Keep the motor temperature within the range shown on the temperature indicator.

Keep the cooling system clean. Flush it out at least twice a year.

Check crankcase, differential and transmission oil levels frequently.

Keep the instruction book handy. Don't "monkey" with the motor; but when repairs and adjustments are necessary, have them made promptly by a competent person.

Using the One-Way Disc

One of the problems created by the increasing use of power machinery in a country where farmers were first accustomed to the use of horses, is that too many people forget that machinery is inanimate and possesses no intelligence. There being no power of reason in iron and steel, this must come from the operator.

A machine is manufactured to do a certain job. Assuming that it was well

designed and reliably manufactured, it will do that job well. It cannot be expected to do other work, with equal satisfaction to the owner. This seems so simple a truth that it would appear to be not worth mentioning. However, the necessity for both mentioning and emphasizing it, is illustrated by the common misuse of the one-way disc. So common is this misuse and so harmful are its effects sometimes that occasionally one finds good farmers who will not use a one-way and still other men who will not use a tractor with a one-way.

A one-way disc is an implement designed to do the work of both the plow and the disc in some circumstances. Under some circumstances it can do this very thing and its increasing popularity proves that it has a real place as a farm implement. Dissatisfaction arises, or poor work results from the use of the one-way, when it is misused. A one-way, with discs of a certain size and discs concaved to a specific degree, is designed to do an ideal job in a fixed type of soil when driven at a definite speed. Soil, size of disc, concavity and speed are, therefore, factors, all of which have to be considered in the use of the one-way.

According to G. N. Denike, assistant in farm machinery at the Dominion Experiment Station, Swift Current, the most adaptable type of one-way to buy is one with the largest and straightest discs. Large discs are desired because they will wear down inevitably; comparatively straight discs because they allow for comparatively high speeds when tractor drawn, without throwing the soil too far. A great deal of the trouble with one-way discs, according to Mr. Denike, is that the majority of farmers with tractors mounted on rubber have a strong tendency to drive all types of discs at the same high speed. The faster the speed the more acres can be covered at approximately the same cost.

If, for example, the one-way is being used on stubble, on land where it is of the greatest importance to maintain the best trash cover possible, driving a well-concaved disc at high speed will bury the trash instead of leaving it on top, whereas using it at the correct speed will leave the trash on top and anchor it in the soil sufficiently so that it cannot be blown away. Securing the same result on different soil types will probably require the use of different speeds. Thus, the use of the one-way is limited to a very considerable degree by the size and shape of the discs.

Another point of importance is illustrated by two photographs taken last summer at the Swift Current Experiment Station. One show the appearance of the soil in September after the one-way disc had been used twice on binder stubble, the first time about May 15 and the second time on July 10. The surface is level, with some of the old stubble showing, but most of it buried. The soil is in good shape to blow. The other photograph shows a plot in the same series, which had been given a one-way treatment on May 15 and the duckfoot cultivator used on July 10, instead of the one-way as in the other plot. The soil is ridged and offers resistance to the wind. Another picture shows the result of using a one-way on a combine stubble. Plenty of stubble is still showing on the surface, except for the black soil showing near the furrow, which may have resulted from an increase in the speed of the tractor.

The Small Combine

J. K. MacKenzie, chief instructor at the Alberta Institute of Technology and Art, Calgary, has prepared some pertinent comment on the use of the combine in central and northern Alberta, which is well worth keeping in mind by all prospective users. Mr. MacKenzie points out that the first combine was developed to meet mountain conditions and that this was followed by the type of combine used now for many years on the open plains. In recent years a third type of combine has appeared on the scene, which was developed primarily to meet the needs of the United States corn-belt. This is a low-cost machine, quite small in size and commonly driven by a power take-off from the tractor engine. It is to this type of combine that Mr. McKenzie refers especially and his comment includes the following:

"In order to arrive at a proper valua-

tion of the usefulness of the corn belt combine in Alberta, it is advisable to consider the harvesting conditions in the area for which it was designed. Apart from the greater variety of combine-harvested crops grown in the midwestern states, the most important feature of harvesting is the great length of the harvest season. Fall wheat is ready for the combine in July, oats and barley in early August, grass seed crops are harvested usually in September, field peas and beans in September or October, whereas soybeans can wait until October or even November if necessary. With the small acreages of these crops on the usual corn-belt farm and the long duration of harvest, neither the factor of time nor that of capacity is very important. Flexibility is much more important than capacity, in a machine which may be required to harvest ten acres of wheat, requiring a cylinder speed of 1,500 r.p.m., on a certain day and a similar acreage of field peas on some later date, when the cylinder speed must not exceed 500 r.p.m.

"In Alberta there is no prolonged harvesting period. A very considerable part of the answer as to why the prairie combine succeeded on the open plains, but failed in the parklands, is supplied by the fact that in general, crops on the open plains ripen earlier and with a greater degree of uniformity than do similar crops in the parklands. This permits a longer harvest season and also safer harvesting. None of the features of the corn-belt combine do anything toward avoiding the hazards of late ripening, early frosts, uneven ripening, or the further fact that crops soaked by equinoctial storms rarely dry out in the parklands.

"Many purchasers of power take-off combines have been subjected to vexatious delays and crop losses because of the limitations of this type of power. In all cases the trouble was solved by the purchase of an auxiliary engine. Had this been done in the first place a considerable amount of trouble could have been avoided. In fact, several manufacturers recommend that such an engine constitute part of the original equipment of the combine. Depending on the size of the combine, the auxiliary engine will mean a price increase of $200 to $250, a fact that should be kept in mind by any person thinking of buying such a combine.

"In the harvesting of grass and clover crops an auxiliary engine on the combine is a necessity. The cutting and threshing of these crops requires more power than is required by wheat. Separation is more difficult, so that the slightest overcrowding results in considerable waste. One combine observed in 1940 was doing an excellent job in a heavy stand of Altaswede clover, but it had an auxiliary engine and the tractor was throttled down to a speed of one mile per hour. When operated at 2.5 miles per hour, the tractor's slowest speed, almost half of the crop was wasted."

Lubricating the Mower

Here are a few brief hints on lubrication taken from Farmer's Bulletin 116 of the Dominion department of agriculture, which can be obtained from any experimental farm, most district representatives' offices, or by writing to Ottawa. The bulletin, incidentally, is a very useful one on mower repairs and adjustments and is well illustrated by drawings.

"Bearings should be kept lubricated at all times during the operation of a mower. The frequency of oiling different parts of a machine varies with the type of lubrication system used, and according to the location and speed of the moving parts. Bearings which are lubricated with machine oil, require more attention than those which are lubricated with grease caps, or grease gun fittings.

"Before lubricating a machine, clean out the oil channels so the lubricant can enter the bearings.

"Knife clips and wear plates should be lubricated frequently when the machine is operating under ordinary field conditions. When cutting on dry, sandy soil, however, it is usually advisable to let the knife and exposed gears run dry.

"Pitman bearings operate at high speed and should be lubricated frequently. (Lubricate once each hour if bearing is designed for machine oil).

"Cutter-bar hinge pins, knife-head

ball, joints on the lifting mechanism, clutch shifts, and similar parts should be lubricated at least once a day with machine oil.

"Gear boxes on oil-bath mowers should be supplied with S.A.E. 30-50 oil. Oil should be added to maintain the proper oil level."

Machine Custom Work Charges

It is the work of agricultural engineers to study costs in the operation of farm equipment and consequently provide a basis on which charges for custom work can be worked out by the individuals concerned. Certain basic cost rates were approved by the western Agricultural Engineering Committee, which can be applied by any farmer doing custom work, either on an hourly, or an acre basis.

From the standpoint of the equipment owner, the hourly basis will probably be found more satisfactory, especially if his equipment is to be operated on land that he does not know, or under conditions that may not be entirely under his own control. He may, for example, be operating a tractor attached to machinery belonging to the owner of the land. If the machinery is not in good operating condition, acre custom charges may be unfair to the tractor owner. This, too, may very well operate the other way and the farmer paying for the job may find his costs too high owing to a poor tractor, or tractor operater. Consequently all scheduled charges are useful primarily as a basis for calculating costs and charges and individual and local conditions must be taken into account in formulating actual charges.

In making recommendations, the committee first arrived at a "basic" rate per hour for the use of a machine or single horse. These are:

Horses—six cents per horse per hour.

Tractors—three cents per hour for each $100 of cost when new.

Seeding and harvesting machines—17 cents per hour for each $100 of cost when new.

Tillage machines—12 cents per hour for each $100 of cost when new.

Thus, a six-horse team would call for a basic rate of 36 cents per hour; a $1,400 tractor (new cost) 42 cents per hour; a $300 drill 51 cents per hour; an $1,800 combine $3.06 per hour; and a $400 one-way disc, 48 cents per hour. Each operator would of course calculate the basic charge for his equipment on the actual cost of his machine when new.

This basic rate is sufficient to provide for interest, depreciation, normal repairs and upkeep, as well as other uncertain factors, such as short moves, financing, fuel, bad debts, collection costs, etc.

The basic rate does not, however, include operating costs, which include fuel, oil, grease (or feed for horses) and labor. These costs are likely to vary locally and local figures must be used. Still other factors such as roughness of the land, stoniness, soil character, size of fields and moisture conditions will also vary with local conditions and influence operating costs. The basic rate will not vary, however, and the rates given above are based on the study of a large number of machines over a period of fifteen years by the Dominion experimental station, Swift Current.

TO calculate the custom charge for a six-horse outfit and 9-foot cultivator costing $160, and for a $1,600 tractor pulling a 12-foot combine costing $1,850, the procedure would be as P. 72, assuming arbitrary local operating costs, including 50 cents per hour for labor.

Custom charges for any other type of outfit or machine can be calculated on the same basis, substituting local operating costs for those used in the table. If farmer A supplies the tractor and B supplies the combine, the total custom charge still remains at $5.64. If each one pays the operating cost for his own machine, A will get $1.55 per hour and B $4.09, or in other words A will pay B the difference, which is $2.54 per hour. Where each does not pay the operating cost of his own machine and they are pooled, or some other arrangement is made, A will get 48 cents per hour (basic tractor cost), and B $3.14 per hour, plus any other division as arranged.

The committee point out that the basic cost rates may be used for the rental of all types of machines with the

HORSE OUTFIT			Cost per hr. of use
Basic cost, 6 horses (6c)		.36	
Operating cost—feed and pasture	.36		
Labor	.50		
Custom charge		.86	
			$1.22
Cultivator (12c per $100 new cost)			.19
Custom charge for horses and cultivator			1.41

TRACTOR OUTFIT			
Basic tractor cost ($1,600 new at 3c per $100)		.48	
Operating cost (fuel, oil, grease)	.57		
Labor	.50		
		1.07	
Custom rate for tractor			1.55
12-ft. combine ($1,850 with aux. motor—17c per $100)		3.14	
Operating cost (fuel, oil, grease)	.45		
Labor	.50		
		.95	
			4.09
Custom charge for tractor and combine			$5.64

exception of tractors, for which the basic figures should be increased by 50 per cent to cover risk when the owner is not responsible for operating his own tractor. The committee also strongly recommends that the hourly basis be used for all custom charges, as the most uniform and equitable method where local conditions and operating costs commonly vary from year to year.

A recent survey made in Saskatchewan by the Saskatchewan Wheat Pool and tabulated by the department of farm management, University of Saskatchewan, offers a convenient comparison between the custom charges recommended by the Agricultural Engineering Committee and those actually current throughout the province. In the figures given below, the average rates for various operations are shown and immediately following, the lowest rate and the highest rate are shown in brackets. The low rates are customary where fuel is relatively low priced and the fields are large, level and free of stones, while the high rates apply where fields are small, stony, rough or otherwise difficult to operate in, and fuel is higher.

Tillage operations: Plowing, $1.60 ($1.00-$2.35); plowing and packing, $1.80 ($1.20-$2.70); plowing and harrowing, $1.80 ($1.20-$2.55); one-way discing, .75 (.65-$1.00); one-way discing and packing, .90 (.75-$1.25); cultivating, .55 (.40-.75); double discing, .60 (.45-$1.00); single discing .35 (.25-.50); rod weeding, .45 (.30-.70); harrowing, .25 (.15-.30); packing, .30 (.20-.50).

Seeding operations: One-way discing with seeder attachment, .90 (.70-$1.35); one-way discing with seeder and packer, $1.05 (.80-$1.45); seeding (drill), .50 (.30-.70); seeding and harrowing or packing, .65 (.40-.90).

Harvesting operations: Cutting (binder) without twine, .75 (.50-$1.00); mowing, .60 (.40-.80); raking, .30 (.20-.45); swathing, .50 (.35-.90); picking-up, $2.05 ($1.50-$2.50); straight combining, $2.15 ($1.75-$2.50).

Tractors: If tractors are hired by the hour, with no labor or fuel supplied, the average charge is 80c per hour up to 10 horsepower, $1.00 per hour from 10 to 20 horsepower and $1.25 per hour over 20 horsepower. Where the tractor owner supplies the operator, but not the fuel, the corresponding rates are $1.20, $1.45 and $1.70.

Combine hourly rental rates (no labor or fuel supplied) are 5 to 8-foot power take-off $1.35 per hour; auxiliary motor 8 to 10-foot cut, $1.65 and $1.90 for 12 to 15-foot cut.

Where machines are hired by the acre, the customary charge for drill is 15 cents with a low of ten cents and a high of 25 cents; disc .10 (.05-.25); one-way .20 (.10-.25); threshing charges as follows: Wheat 8c, oats 5c, barley 6c, rye 8c, flax 16c; hire of team $1.20; team and wagon $1.50; team, wagon and one man $5.50. Trucking charges for wheat up to two miles average 1¼ cents per bushel; and over two miles and up to ten miles, an additional one-half cent per bushel per mile.